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Peat Bog Investigations in Northeastern Pennsylvania

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Peat Bog Investigations in Northeastern Pennsylvania

by Curtis D. Edgerton
U. S. Bureau of Mines

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1969

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PREFACE

A product of fairly recent geological processes, peat is a very marketable commodity which is too often overlooked as an important resource of an area.

This report is intended to highlight the occurrence of many outstanding peat deposits in northeastern Pennsylvania. It is hoped that the data presented here will stimulate further interest and economic development of this outstanding resource, and, thus, add to Pennsylvania's present high rank in the nation as a peat producer.

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PEAT BOG INVESTIGATIONS IN NORTHEASTERN PENNSYLVANIA

By

Curtis D. Edgerton*

ABSTRACT

The U. S. Bureau of Mines conducted this investigation to locate unexploited peat bogs in northeastern Pennsylvania, to determine their characteristics and harvestable reserves, and to suggest suitable methods of harvesting and processing the peat.

Nine bogs, each containing harvestable reserves in excess of 100,000 short tons, were explored. Commercial sampling equipment was used to obtain samples for analysis. Examination of the samples indicated that most of the peat was of the reed-sedge variety, although some peat humus and small amounts of sphagnum-moss peat were found.

The study revealed that the nine bogs could be suitably harvested and the peat processed by readily available commercial earthmoving and farming equipment.

Peat produced in northeastern Pennsylvania should find ready acceptance in local markets and in those along the Atlantic Seaboard.

INTRODUCTION

At the request of the President's Appalachian Regional Commission (established by Congress as Public Law 89-4, 89th Congress, 53, March 9, 1965), this report is designed to present factual data which might lead to the establishment of a broad and profitable peat industry in an area of economic depression. This would result in (1) an inflow of new investment capital, (2) needed employment, and (3) increased production of peat to meet a rising demand.

The U. S. Bureau of Mines has long been interested in peat resources and has published extensively in this field (see references). The origin, production, utilization, reserves, chemistry, carbonization, and briquetting of peat are among the topics covered in Bureau of Mines publications. In addition, the Bureau of Mines publishes annually in its Minerals Yearbook the statistics on production, sales, value, and imports of peat.

The U. S. Geological Survey estimates peat reserves in northeastern Pennsylvania to be in excess of 10,000,000 short tons (Cornelia C. Cameron, oral communication). Investigation of the nine bogs covered in this report indicates that they alone contain peat reserves totaling 1,743,000 short tons.

* Geologist, Pittsburgh Office of Mineral Resources, U. S. Bureau of Mines, Pittsburgh, Pa.

ACKNOWLEDGMENTS

The author gratefully acknowledges the cooperation and assistance of all those who provided information without which this report could not have been prepared. Particular thanks are due Robert A. Weeks and Dr. Cornelia C. Cameron of the U. S. Geological Survey. Mr. Weeks provided invaluable assistance in coordinating phases of work between the U. S. Geological Survey and the U. S. Bureau of Mines. Dr. Cameron suggested suitable methods of exploration and sampling and spent several days in the field with the author.

Mr. Joseph A. Hartman, President of Nursery Specialty Products, Inc., Greenwich, Conn., gave freely of his time and knowledge of peat harvesting and marketing methods. Mr. David Dennison, Treasurer and Assistant Secretary of the Peat Producers Association of the United States, provided valuable information concerning the production and sale of peat.

Finally, the author acknowledges the cooperation of all landowners who gave permission to conduct field work on their properties.

DEFINITION OF TERMS

Approaches—The surface of ground immediately surrounding a peat bog.

Basin—The depression in which a peat deposit has accumulated.

Glacial drift—Rock debris transported by a glacier and deposited in place upon the melting or retreat of the glacier.

Harvestable peat—Peat in a bog which can be harvested without accumulating an excessive amount of undesirable rock or woody material; marketable peat.

Peat—Vegetable matter consisting of grasses, sedges, reeds, mosses, trees, and other woody material that has accumulated underwater or in a water-saturated environment and has reached various stages of decomposition.

Moss peat—Peat composed of the sphagnum, hypnum, and other mosses group (Sheridan, 1965; Cameron, 1968).

Reed-sedge peat—Peat composed of the reed sedge, shrub and tree groups (Sheridan, 1968).

Peat humus—Any peat so decomposed that it has lost its botanical identity (Sheridan, 1968).

Perched water table—A water table lying above the ordinary water table and held there by an underlying impervious bed generally of small areal extent.

Traverse—A line surveyed across a plot of ground.

THE PENNSYLVANIA PEAT INDUSTRY

In 1966, Pennsylvania ranked second in the United States with 8.2 percent of production and 8.7 percent of domestic sales. Of a total of 144 active peat operations in the United States, 13 were in Pennsylvania; 8 of the 13 were in northeastern Pennsylvania. The average production per Pennsylvania operation was 3,840 short tons compared with the national average of 4,240 short tons. Pennsylvania peat sold at an average price of \$10.61 per short ton, while nationally, the average price was \$10.73. Salient peat statistics in Pennsylvania are given in Table 1.

Table 1.—*Salient Peat Statistics in Pennsylvania*

Year	Active plants	Production, short tons	Commercial sales		
			Short tons	Value	
				Total	Average
1957	5	26,086	26,086	\$235,752	\$9.04
1958	5	23,623	23,623	202,718	8.58
1959	6	26,948	22,131	232,391	10.50
1960	6	30,837	29,237	311,757	10.66
1961	6	27,993	24,993	251,154	10.05
1962	7	32,936	32,936	368,717	11.19
1963	7	44,910	33,952	338,667	9.97
1964	10	43,500	39,500	397,123	10.05
1965	12	57,378	45,600	527,285	11.56
1966	13	49,912	52,912	561,521	10.61

Source: U. S. Bureau of Mines

Northeastern Pennsylvania Peat

The peat in the nine bogs investigated is predominantly of the reed-sedge variety. This is typically light to dark brown and contains much partially decomposed woody material.

All of the bogs explored contain small amounts of humus at the surface. This rarely exceeds 1 foot in depth and is generally found near the edges of the peat deposits. Moss peat exists in some of the bogs, especially in areas which were extremely wet. Usually in these areas, sphagnum moss growing on the surface was identified. Moss peat, like humus, was also limited in quantity.

UTILIZATION OF PEAT

Peat is generally considered to be a fuel, and in Europe, large quantities of peat are consumed as fuel by power plants, industry, and for domestic heating purposes. However, in the United States, peat cannot compete in the fuels market with petroleum, natural gas, coal, or nuclear power.

The major use for peat in the United States is for general soil improvement. Peat tends to bind together sandy soils and to make clayey soils more porous. Peat has little fertilizing capability. The nitrogen content seldom exceeds 3.5 percent, and this has a tendency to be released slowly.

Small quantities of peat are used in potting soils, as packing for flowers and shrubs, as a seed inoculant, for mushroom beds, for the manufacture of mixed fertilizers, and for stable and poultry litter.

Commercial sales of peat in the United States in 1966, by uses, are given in Table 2.

Recommended uses and application rates for different types of peat are given in Table 3.

CLASSIFICATIONS OF PEAT

Although various government agencies, private and public institutions, and industry associations have attempted to classify peat according to physical, chemical, or generic properties, no such classification has yet proved completely satisfactory.

The Bureau of Mines classifies peat for statistical purposes as moss peat (erroneously called "peat moss"), reed-sedge peat, and peat humus. These peat varieties are illustrated in Figure 1. This report follows the Bureau's classification.

FEDERAL SPECIFICATIONS

The sale of peat in interstate commerce is regulated by the Federal Trade Commission. The Commission specifies that a product sold as peat must be any partially decomposed plant material that has accumulated either underwater or in a water-saturated environment. It further states that at least 75 percent of the material, by dry weight, be composed of peat, with the remainder to consist of normally associated soil materials. Federal Government purchases of peat are governed by specifications developed by the Federal Supply Service, General Services Administration. Current specification Q-P-166e, issued May 10, 1961, lists four types of peat: (1) sphagnum-moss peat, (2) other moss peats, (3) humus peat, and (4) reed-sedge peat.

CHARACTERISTICS OF PEAT DEPOSITS

Peat is a product of the partial decay of plants which are, for the most part, aquatic. These plants are generally sedges, reeds, rushes, mosses, shrubs, and trees. Commonly, more than one type of plant goes into the making of a peat deposit.

Table 2.—Commercial Sales of Peat in the United States in 1966 by Uses¹

Use	In bulk			In packages			Total	
	Short tons	Value	Short tons	Value	Short tons	Value		
Soil improvement	279,041	\$2,231,972	294,381	\$3,416,366	573,422	\$5,648,338		
Potting soils	3,617	118,913	8,647	458,956	12,264	477,869		
Packing flowers, shrubs, etc. ²	4,417	48,998	1,936	32,485	6,353	81,483		
Seed inoculant	—	—	2,260	192,822	2,260	192,822		
Mushroom beds	3,787	40,443	—	—	3,787	40,443		
In mixed fertilizers	7,772	60,326	—	—	7,772	60,326		
Total	298,634	\$2,500,652	307,224	\$4,100,629	605,858	\$6,501,281		

¹ U. S. Bureau of Mines, Minerals Yearbook, v. I-II, 1966, p. 804.² Includes small amount sold for earthworm culture.

Table 3.—Recommended Uses and Application Rates for Different Types of Peat¹

Peat use	Normal application ²	Sphagnum-moss peat	Hypnum-moss peat	Reed-sedge peat	Peat humus (decomposed)
Soil conditioning	2-inch layer worked into soil	Fair	Good	Good	Good
Top dressing lawns, golf courses	1/8-1/4-inch layer worked into soil	Fair	Good	Good	Good
Surface mulch	2-inch layer	Excellent	Fair	Fair	Poor
Potting soil mix	50 percent peat, 50 percent vermiculite or soil	Excellent	Good	Good	Fair
Golf green soil mix ³	80 percent sand, 10 percent clay loam, 10 percent peat	Poor	Good	Good	Excellent
Rooting cuttings	50 percent peat, 50 percent vermiculite	Excellent	Good	Fair	Poor
Seed flat germination	Pure milled peat	Excellent	Good	Fair	Poor
For acid-loving plants	25 percent mixture in soil	Excellent	Not recommended	Good, if below pH 4.8	Not recommended
For acid-intolerant plants	25 percent mixture in soil	Recommended only if limed	Good	Good, if above pH 4.8	Good
Shipping tender plants	Wrap roots (wet)	Excellent	Fair	Fair	Poor
Adding stable organic matter	2-inch layer worked into soil	Poor	Fair	Good	Excellent
Liquid absorbent (litter)	2-inch layer on floor	Excellent	Fair	Fair	Poor
Nitrogen source	Soil mixes top-dressing	Poor	Good	Fair	Good

¹ Source: Michigan State University, Cooperative Extension Service, Bull. No. 516, Robert E. Lucas, Paul E. Rieke, and Rouse E. Farnham.² By volume.³ U. S. Golf Association general formula. Often needs modification for specific situations.

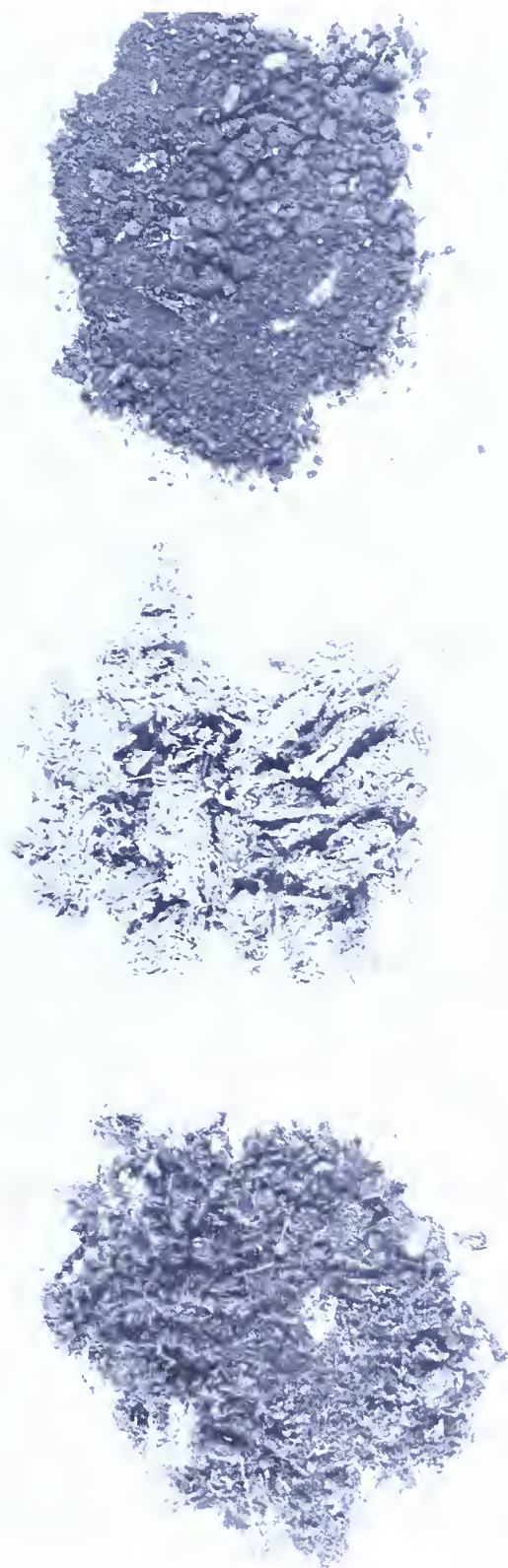


Figure 1. Typical reed-sedge peat, sphagnum-moss peat, and peat humus (left to right) .

Disintegration of plant material into peat is brought about by bacterial action upon plant and woody material in an excessively moist environment. Accumulations of peat are found in coastal and tidal swamps, in abandoned oxbow lakes and similar features, and in areas of glaciated terrain.

Basins in northeastern Pennsylvania in which peat has accumulated are features of glacial activity. They have been formed either by scouring and plucking or are the result of the damming of valleys and topographic depressions by morainic deposits.

The color of peat ranges from yellow to nearly black. Most of the peat in northeastern Pennsylvania is light to dark brown.

EXPLORATION

During the course of field work, 12 peat bogs were explored in detail. These bogs were selected from a listing prepared by Dr. Cornelia C. Cameron of the U. S. Geological Survey who had done prior reconnaissance work in the area. U. S. Bureau of Mines project personnel chose a reserve figure of 100,000 short tons of harvestable, air-dried peat per bog as a minimum for potential commercial exploitation. This figure was arrived at after consulting with representatives of the peat industry. Detailed exploration of the bogs indicated that three of these contained less than 100,000 short tons of harvestable peat; these are not discussed in this report. The remaining nine appear to be commercially exploitable. Locations of the nine bogs are shown in Figure 2.

Principal facts determined in the field were the areal extent of the peat bogs, thickness and character of the peat, character of the bog surface, the relative ease with which drainage might be achieved, and the possibility of exploiting the underclay in conjunction with the peat harvesting operation.

Traverses, aligned by Brunton compass and measured with a surveyor's chain, were made across the bogs in predetermined directions to provide as much coverage of the bogs as possible. The thickness and character of the peat were determined at selected points by probing and sampling with a peat sampler. The device used is distributed by Soiltest, Incorporated, of Evanston, Ill.* With it, a sample 1 inch in diameter and about 10 inches in length can be obtained. A conical piston is fitted into the barrel of the sampler. The sampler is illustrated in the closed position in Figure 3A, and in the open position in Figure 3B. Steel rods are fitted to the piston, and the assembly is thrust through the layer of

* Mention of the company name is provided for identification of equipment only and does not necessarily imply endorsement by the Bureau of Mines.

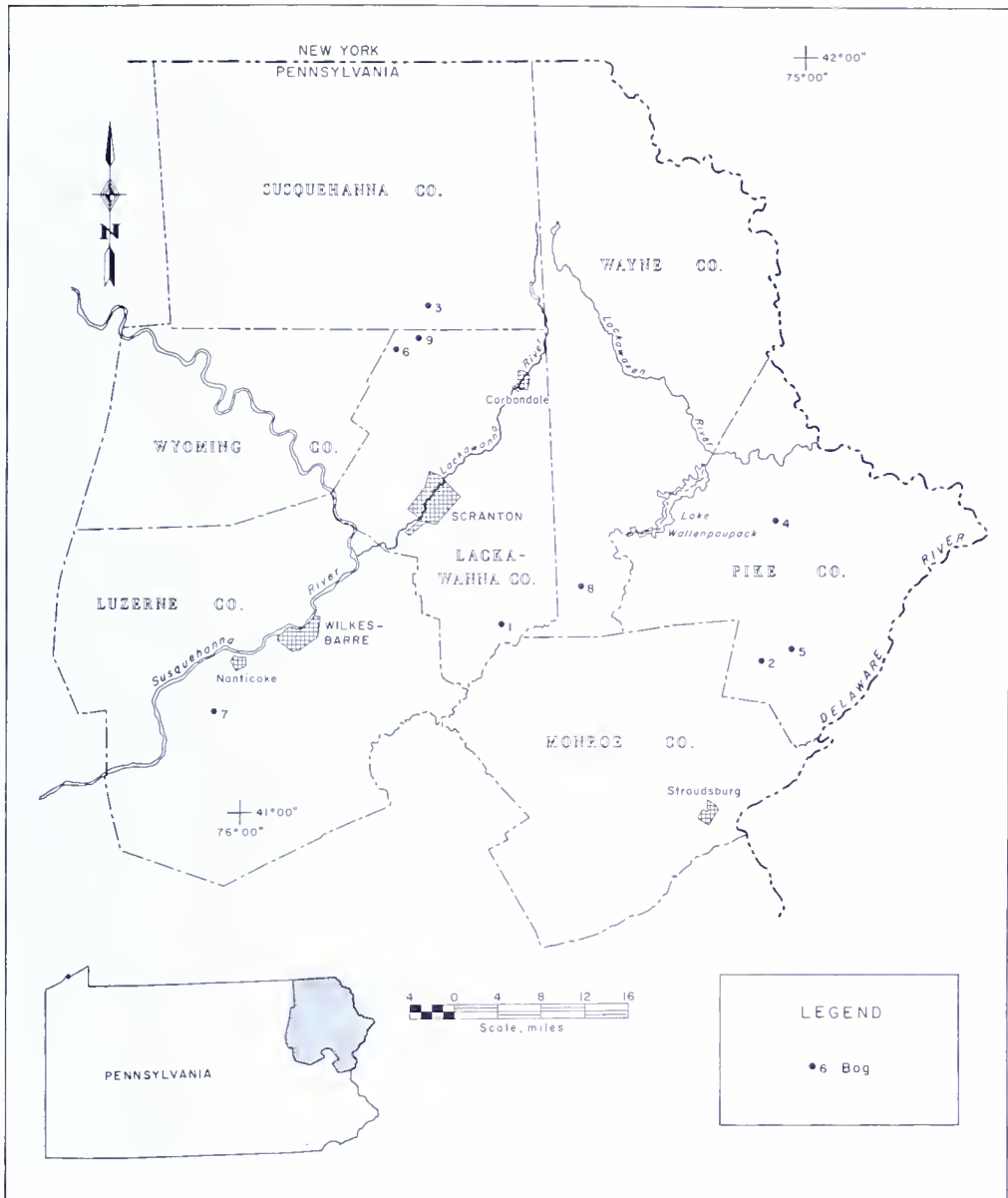


Figure 2. Location of bogs explored in northeastern Pennsylvania.

surface muck into the peat (Figure 3C). The piston is then activated by pulling up on the rods. A sample of peat is thus drawn by suction into the barrel, retrieved from the hole, and ejected from the sampler (Figure 3D). By adding sections of rod, depths up to 42 feet were probed and sampled at selected stations. Data obtained at these stations were used to construct the accompanying isopach maps and cross sections, all of which show only harvestable peat. Surface muck and underclay are not indicated.



Figure 3. A (top, left) Peat sampler in closed position; B (top, right) Peat sampler in open position; C (bottom, left) Driving peat sampler; and D (bottom, right) Ejecting peat sample.

BOG ONE

Bog One (Figure 4) is an elongate basin whose axis trends approximately N. 8° W. The peat deposit is about 4,050 feet long, has a maximum width of 1,000 feet, and lies at approximately 1,890 feet above mean sea level. The bog covers about 65 acres. The approximate center



Figure 4. Surface vegetation on Bog One.

of the bog lies at $41^{\circ} 15' 33''$ N. and $75^{\circ} 32' 7''$ W., in Lackawanna County. Bog One is on the U. S. Geological Survey's Moscow quadrangle ($7\frac{1}{2}$ -minute).

At the time the bog was explored (October 1966) the water table was just below the surface except at the extreme southern end, where a slightly perched water table was present. At this southern end, the surface was extremely unstable, and the field party was unable to continue exploration. However, the peat here is probably not more than 3 feet thick.

Probing revealed a rather symmetrical basin containing peat ranging in thickness to a maximum of 26 feet (Figures 4 and 5). The average peat thickness is 11 feet. No large irregularities appear on the basin floor. Most of the peat is of the typical reed-sedge variety, with some undecomposed woody material occurring at a depth of about 4 feet in localized areas.

Harvestable peat reserves of Bog One are calculated to be 145,000 short tons of air-dried peat.

Table 4.—*Analyses of Peat Samples from Bog One*

<i>Sample No.</i>	<i>Depth</i>	<i>Percent Moisture Content¹</i>	<i>Percent Ash Content¹</i>	<i>Percent Organic Content²</i>	<i>Percent Moisture Absorp- tion³</i>	<i>pH</i>	<i>Percent Fiber Content</i>
1	5	90.8	0.9	8.3	933	5.0	42.9
2	14	90.6	1.2	8.2	994	5.3	40.7
3	10	95.3	0.2	4.5	1671	4.3	26.2

¹ As received.² Calculated.³ Dry basis.

The above samples are typical of reed-sedge peat. This material would be useful for general soil conditioning, top-dressing, potting soil mix, and golf greens. Samples 1 and 2 are suitable for soil mixes for acid-intolerant plants.

A light-gray, soft to hard underclay is present over most of the basin floor. There are, however, small areas in which the peat either lies directly on rock, or where small piles of glacial drift of low relief protrude upward through the underclay and are in direct contact with the peat. These should prove insignificant in peat-harvesting operations. Locally, the underclay was silty—enough to cause difficulty in ejecting samples from the sampler. An evaluation of the underclay is given in the Appendix.

Approximately 250 feet south of Bog One is a small recreational lake into which the normal outflow from the bog is discharged. The difference in elevation between the bog surface and the lake is about 19 feet. As a maximum peat thickness of 26 feet exists in Bog One it will be necessary to drain to a lower level to ensure drainage of the lower depth of the bog. This could be achieved by ditching around the lake for a distance of approximately 1,500 feet. At this point, the outflow would enter a small stream which ultimately empties into Silver Creek.

BOG TWO

Bog Two, known as Big Swamp, is an irregularly shaped bog with a maximum length of 4,600 feet, and a maximum width of 2,770 feet. The long axis describes a gentle S-curve and takes the approximate trend of N. 10° E. The surface of the bog lies at an elevation of about 1,195 feet above mean sea level. Bog Two has a surface area of about 190 acres. Its approximate center is located at 41° 11' 43" N. and 75° 5' 42" W. in Pike County. Bog Two is on the U. S. Geological Survey's Twelvemile Pond quadrangle (7½-minute).



Figure 5. Isopach map of Bog One with topography of surrounding terrain.

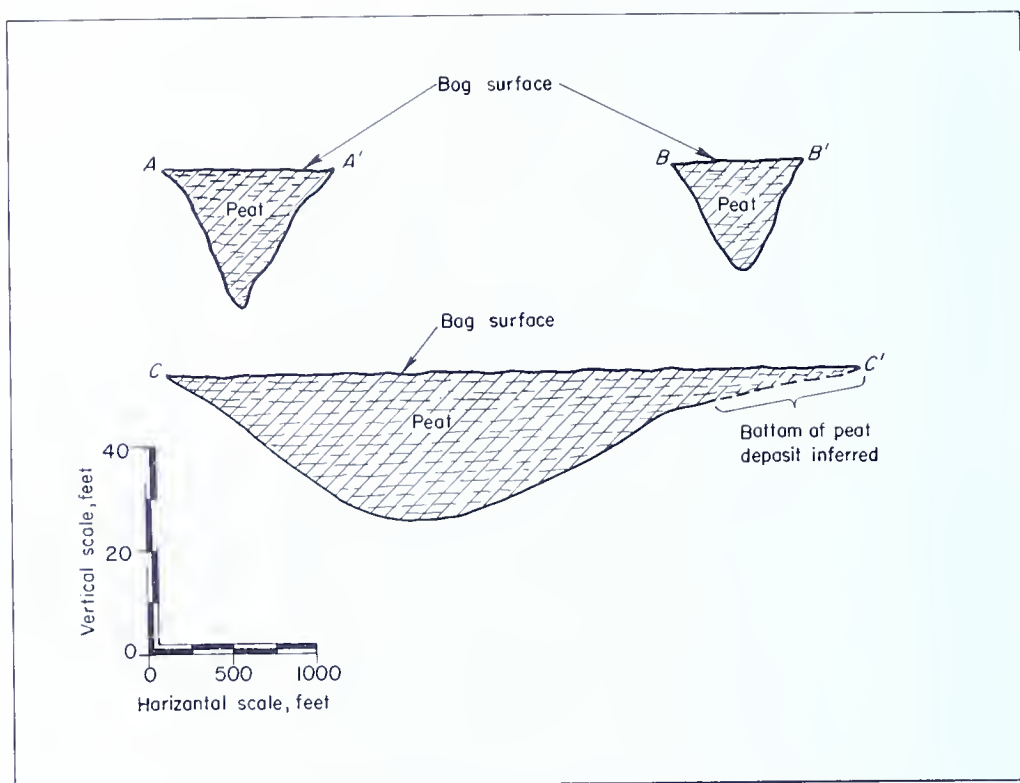


Figure 6. Vertical cross sections of Bog One.

Probing revealed an irregularly shaped basin with an asymmetrical floor (Figures 7 and 8). A trough with a maximum depth of 26 feet runs along the eastern half and parallels the eastern edge of the peat deposit. The western half of the bog is characterized by a gently-sloping floor, gradually increasing in slope to the east until the maximum depth in the trough is reached. Farther eastward the floor rises abruptly. No significant irregularities were found on the floor. The average thickness of peat throughout the bog is 12 feet. Some poorly decomposed material occurs locally at depths of about 3 feet.

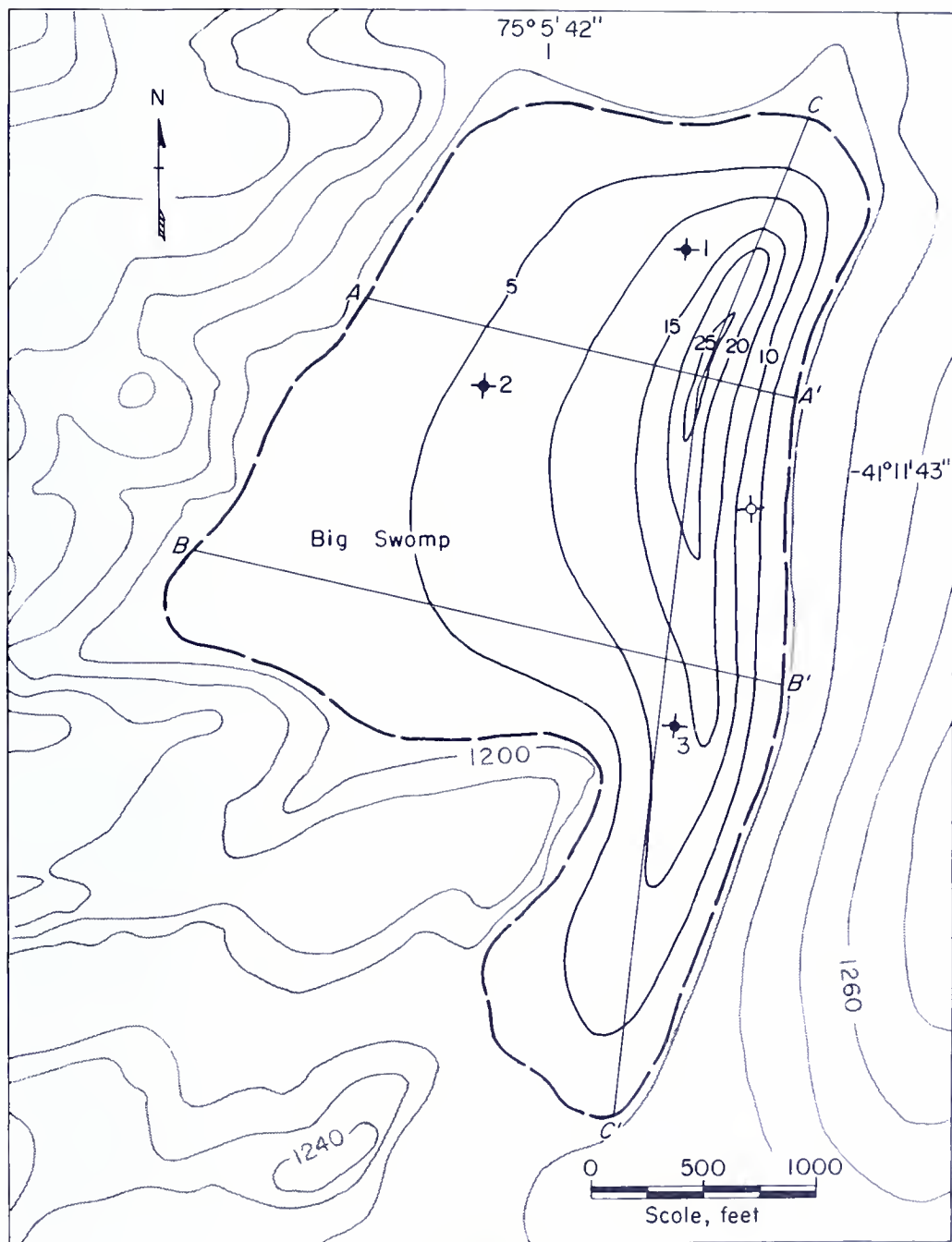
Table 5.—Analyses of Peat Samples from Bog Two

Sample No.	Depth	Percent Moisture Content ¹	Percent Ash Content ¹	Percent Organic Content ²	Percent Moisture Absorption ³	pH	Percent Fiber Content
1	3	90.0	0.8	9.2	748	5.0	34.8
2	4	91.1	0.9	8.0	850	4.9	52.1
3	13	91.7	2.4	5.9	980	5.3	27.6

¹ As received.

² Calculated.

³ Dry basis.



LEGEND	
Topographic contours (20 ft. interval)	Perimeter of peat deposit
Isopachous contours (5 ft. interval)	Drive sample, peat.....
Vertical cross section..... A—A'	Drive sample, clay.....

Figure 7. Isopach map of Bog Two with topography of surrounding terrain.

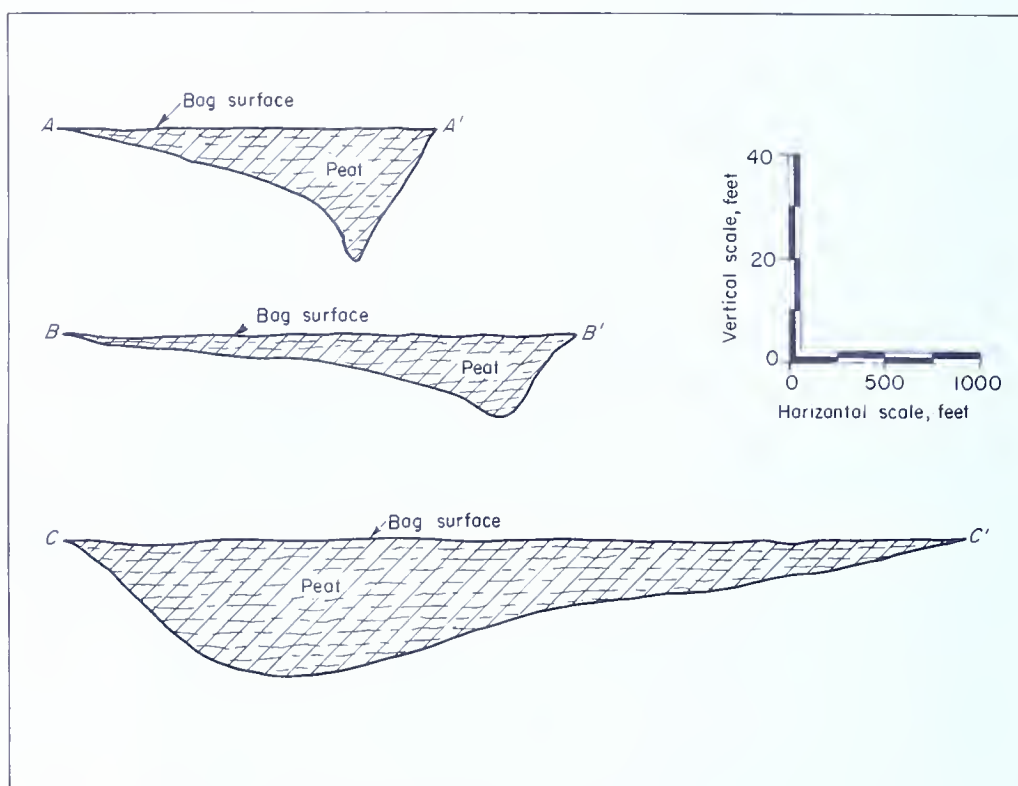


Figure 8. Vertical cross sections of Bog Two.

The samples taken from Bog Two are typically reed sedge. This material would be suitable for general soil conditioning, top dressing, golf greens, and as potting soil for acid-intolerant plants.

In most parts of the bog, the peat becomes clayey toward the bottom, where it finally rests on a soft to compact, light-gray underclay. In a few small areas the clay is not present. Two evaluations of the clay are given in the Appendix.

Harvestable peat reserves of Bog Two are calculated to be 460,000 short tons of air-dried peat.

A major engineering difficulty in harvesting peat from Bog Two would be in establishing drainage. Two possibilities exist, both of which should be studied in detail before attempting drainage. The first entails draining to the southeast around the eastern edge of Twelvemile Pond. This would necessitate passing the outflow through a culvert under State Highway 402 at a point slightly south of Hunters Range School, and thence into Saw Creek Pond which discharges into Saw Creek. This would require approximately 10,000 feet of drainage ditch. It may be possible to bypass Saw Creek Pond and discharge directly into Saw

Creek. This, however, would require an additional 5,000 feet of ditching. The differences in elevation between Bog Two and Saw Creek Pond and Saw Creek (at a suitable point of discharge) are 225 feet and 260 feet, respectively. Thus, sufficient gradient exists for drainage.

The second possibility for drainage is to the south and west. Ditching would bypass Twelvemile Pond on the west. The outflow would then be led westward to an area of steep gradient, where it could be discharged into Spruce Run. The area between Bog Two and Twelvemile Pond, and immediately west of the latter, is virtually flat, and drainage here would, at best, be a time-consuming operation. Approximately 8,500 feet of ditching would be required. The gradient is about 100 feet.

BOG THREE

Bog Three (Figure 9), known as Robinson Lake, is an elongate deposit with a long axis slightly convex westward. The trend of the bog is approximately north-south. The length of the peat deposit is 4,200 feet, and the maximum width is 1,750 feet. The bog is 1,210 feet above mean sea level and covers about 83 acres. The approximate center of Bog Three is located at $41^{\circ} 40' 40''$ N. and $75^{\circ} 40' 49''$ W. in Susquehanna County. Bog Three is shown on the U. S. Geological Survey's Lenoxville quadrangle ($7\frac{1}{2}$ -minute).



Figure 9. Bog Three showing hummocks of genus *Caryx*.

Bog Three is significant because of an unusually great thickness of peat. The greatest thickness is in the central part of the basin, where 34 feet of peat was encountered. The average thickness of peat throughout the bog is 17 feet. The peat is generally reed sedge which in places becomes clayey for about 2 feet immediately above an underclay. Some moss peat is found at the surface, but this is no more than 1 foot thick and occurs only locally.

Table 6.—*Analyses of Peat Samples from Bog Three*

Sample No.	Depth	Percent	Percent	Percent	Percent	pH	Percent
		Moisture Content ¹	Ash Content ¹	Organic Content ²	Moisture Absorption ³		
1	7	92.8	0.5	5.7	1181	5.4	39.4
2	7	85.1	9.3	5.6	547	4.9	44.6
3	7	96.9	1.0	2.1	1593	5.4	51.9
4	4	91.0	1.1	7.9	1336	5.4	37.7

¹ As received.

² Calculated.

³ Dry basis.

The peat in Bog Three, mostly reed sedge, is suitable for use as a general soil conditioner, for golf greens, and as a potting soil mix for acid-intolerant plants.

The underclay in Bog Three is soft, light gray, and occasionally silty. Two evaluations of the underclay are given in the Appendix.

Harvestable reserves of Bog Three are calculated to be 281,000 short tons of air-dried peat.

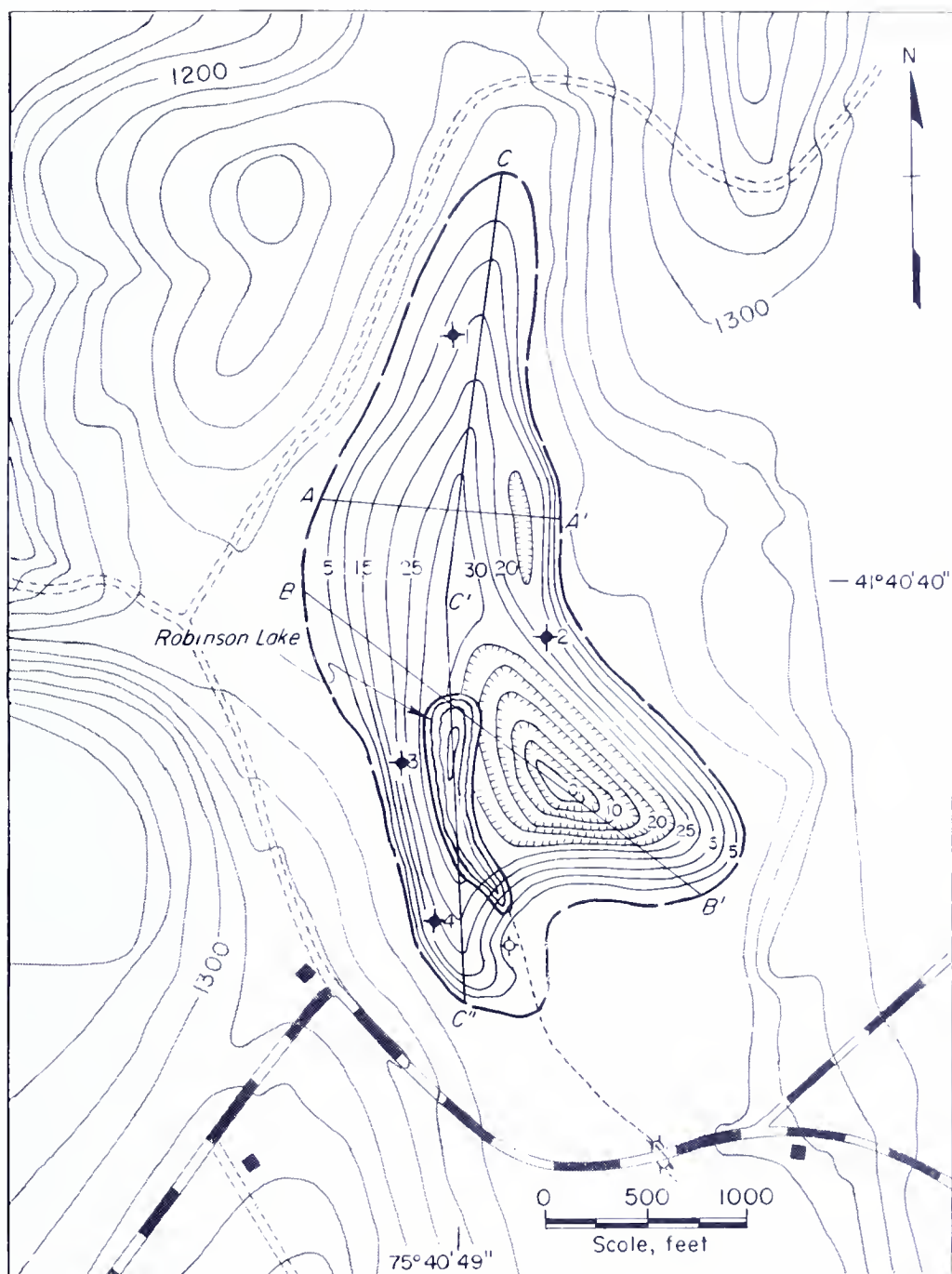
Two piles of glacial drift truncate the underclay and extend upward into the peat. The smaller of these is located midway along the eastern edge; the larger lies in the southeast quadrant and is exposed at the surface (Figures 10 and 11).

Some peat has been harvested from the southern end of the bog by local residents, but the quantity was not more than a few tons.

Draining of Bog Three can be readily accomplished. The natural drainage from Robinson Lake is to the southeast, where the outflow discharges into a small stockpond, and subsequently into the East Branch of Tunkhannock Creek. The distance from the southern margin of the peat deposit and the stockpond is about 500 feet.

BOG FOUR

Bog Four is an inverted Y-shaped bog known as Smiths Swamp. The maximum length of the peat deposit is 5,300 feet; the maximum width



LEGEND		
Topographic contours (20 ft. interval)		Perimeter of peat deposit
Isopachous contours (5 ft. interval)		Vertical cross section
Where hachured, indicates areas of decreasing peat thickness.		Lake or pond
Narrow, hard surface road		Drive sample, clay
Unimproved road		Drive sample, peat
Stream		Building
		Culvert

Figure 10. Isopach map of Bog Three with topography of surrounding terrain.

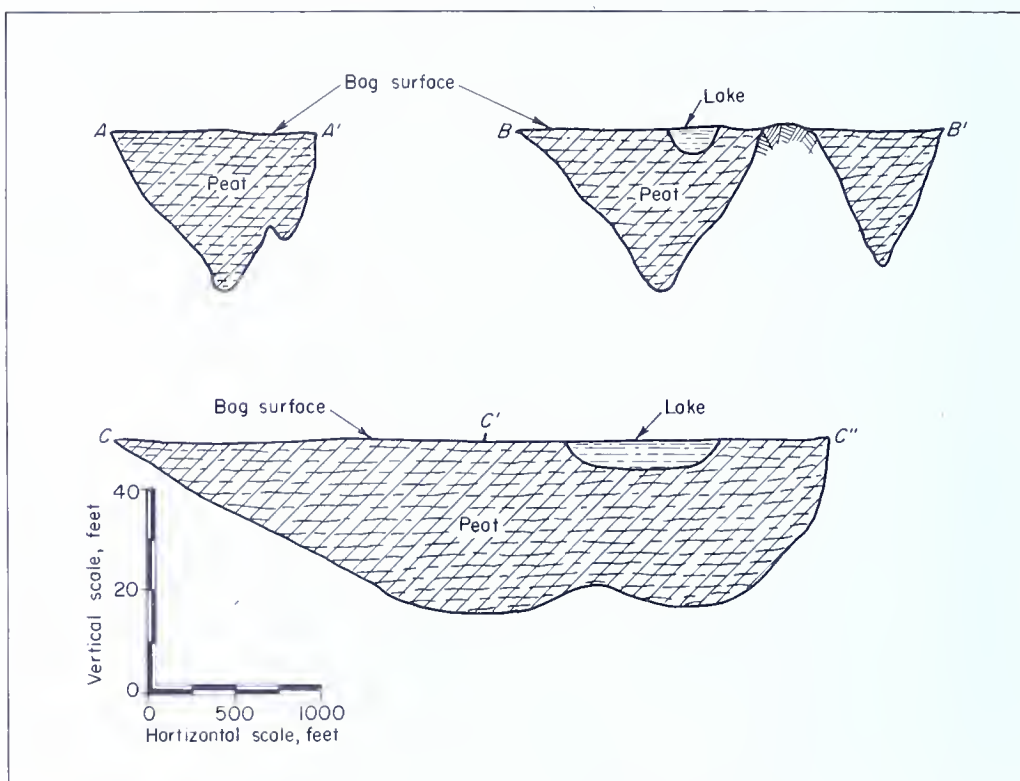


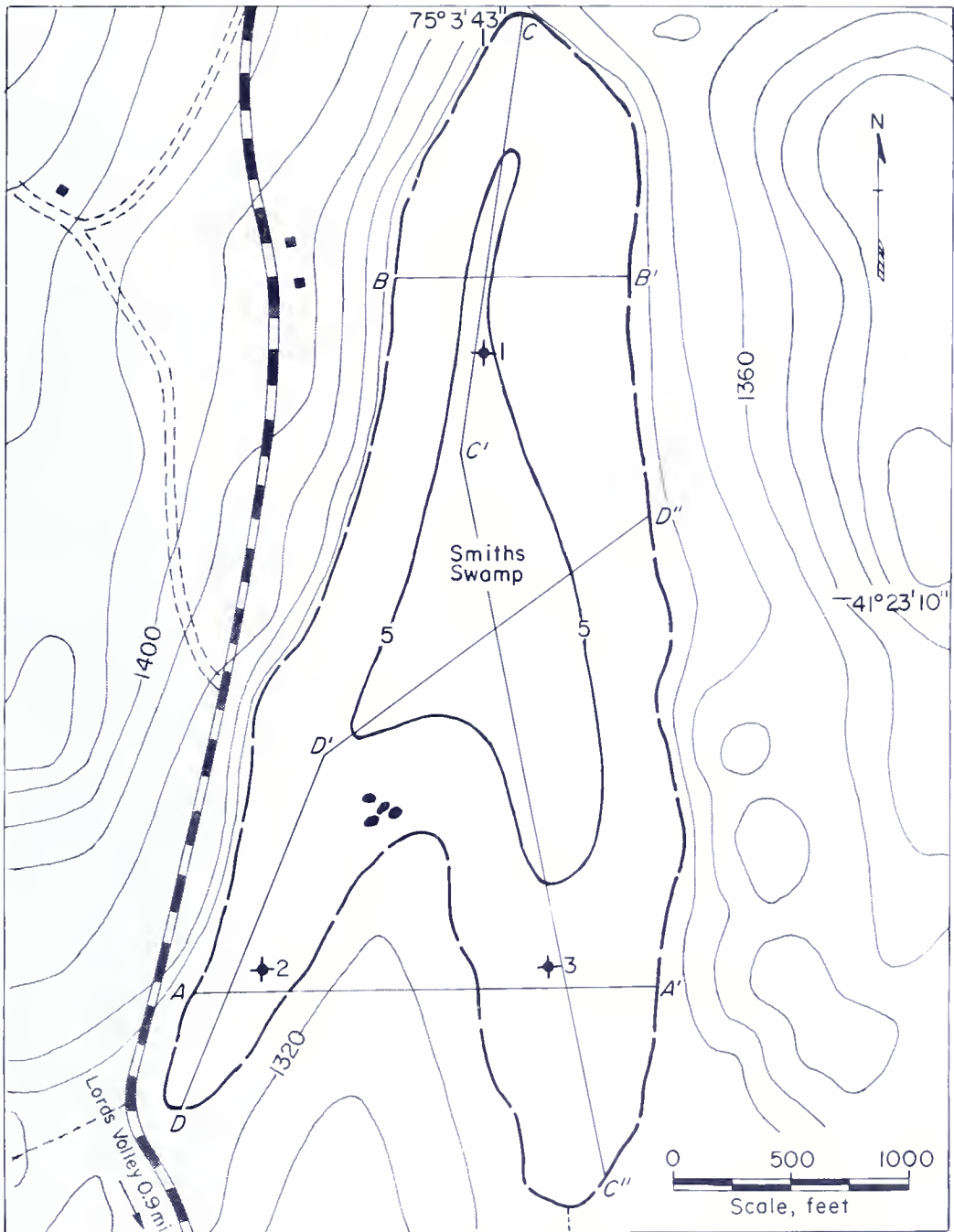
Figure 11. Vertical cross sections of Bog Three.

is slightly more than 2,000 feet. In area, the bog covers about 145 acres. The trend of the long axis is approximately N. 5° E., and the surface elevation is 1,310 feet above mean sea level. The approximate center of the bog is located at $41^{\circ} 23' 10''$ N. and $75^{\circ} 3' 43''$ W. in Pike County. Bog Four is shown on the U. S. Geological Survey's Hawley, Pa., quadrangle (15-minute).

Characteristic of Bog Four is the relative thinness of the peat deposit. The average thickness is 4 feet. Most of the peat is of the reed-sedge variety, although peat humus and moss peat are found at the surface in some areas. Where underclay is present, the bottom foot of peat is generally clayey.

The basin is rather symmetrical along its major axis. At the south end, a ridge of glacial debris extends northward into the peat deposit about 1,400 feet. The configuration of the basin floor along the short axis is asymmetrical, with the thickest part of the bog lying in the eastern half (Figures 12 and 13). No major irregularities were found on the basin floor except for a few large glacial boulders which crop out near the northwest margin of the topographic ridge (Figure 14).

Harvestable reserves in Bog Four are calculated to be 115,000 short tons of air-dried peat.



LEGEND

Topographic contours (20 ft. interval)
 Isopachous contours (5 ft. interval)
 Glacial boulders.....
 Improved road.....
 Unimproved road.....

Perimeter of peat deposit
 Vertical cross section... A—A'
 Drive sample, peat....
 Building.....
 Trail.....

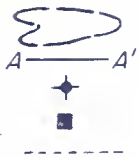


Figure 12. Isopach map of Bog Four with topography of surrounding terrain.

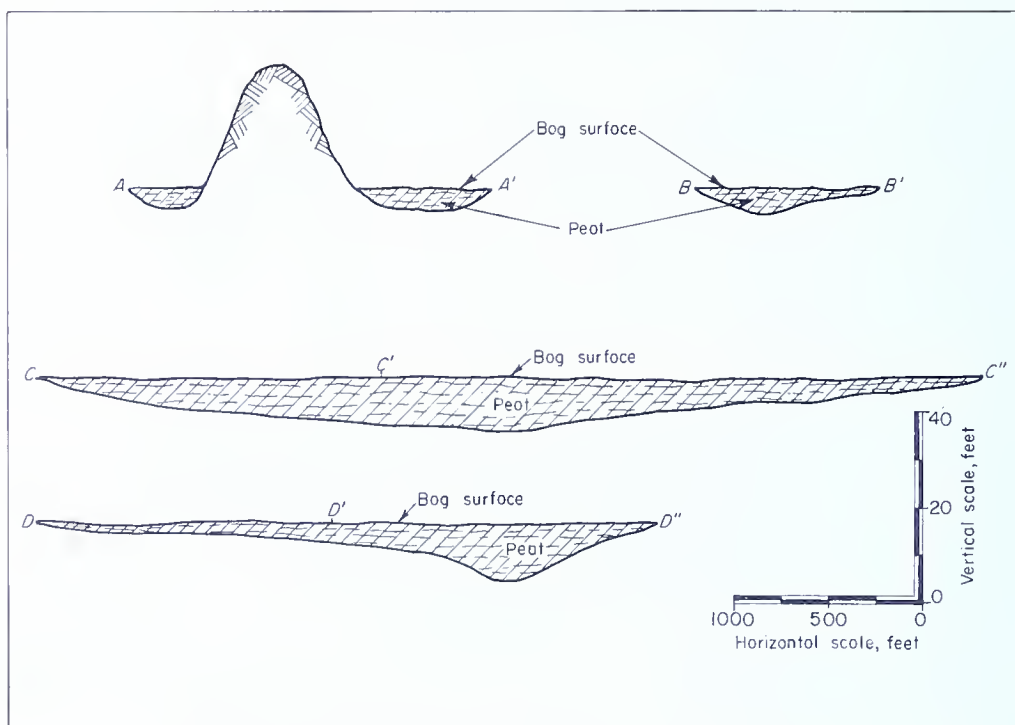


Figure 13. Vertical cross sections of Bog Four.



Figure 14. Glacial-boulder outcropping on surface of Bog Four.

Table 7.—*Analyses of Peat Samples from Bog Four*

<i>Sample No.</i>	<i>Depth</i>	<i>Percent Moisture Content¹</i>	<i>Percent Ash Content¹</i>	<i>Percent Organic Content²</i>	<i>Percent Moisture Absorption³</i>	<i>pH</i>	<i>Percent Fiber Content</i>
1	5	93.7	0.4	5.9	1198	5.0	41.3
2	3	87.9	4.9	7.2	692	5.6	36.6
3	3	82.5	11.4	6.1	555	4.1	19.0

¹ As received.² Calculated.³ Dry basis.

Samples from Bog Four were reed-sedge peat, but sample Number 3 contained a relatively large fraction of clay. General soil improvement, golf course application, and potting soil mixes for acid-intolerant plants are uses for the peat in Bog Four.

The underclay in Bog Four is not continuous throughout the basin. There are many areas in which the peat lies directly on rock. Where there is underclay, it is light gray, compact, and hard. An evaluation of the underclay is given in the Appendix.

Draining of Bog Four would present no problems. This would require only the deepening of the natural drainage channel leading from the southern end of the bog into Shohola Creek. The distance is about 1,500 feet and the gradient is 30 feet.

BOG FIVE

Bog Five is an irregularly shaped swamp in which the principal peat deposit covers 217 acres. It is contiguous to marshy areas to the south and northeast which probably also contain peat, although they were not investigated. The peat deposit has no definite axis. The swamp is known as Nebo Swamp. Nebo Island, which covers about 29 acres, occupies the east-central portion of the bog, truncates the peat deposit, and reaches an elevation of about 1,310 feet, some 35 feet above the surface of the bog immediately to the west. The bog surface is not horizontal, but slopes gently to the northeast. The peat deposit is about 5,000 feet at its widest part.

The approximate center of Bog Five is located at 41° 12' 50" N. and 75° 2' 7" W. in Pike County. The bog is shown on the U. S. Geological Survey's Twelvemile Pond quadrangle (7½-minute).

Bog Five, like Smiths Swamp (Bog Four) which is in the same vicinity, is characterized by a thin peat deposit. The average peat thickness is 4 feet. Most of the peat is reed sedge, with humus and moss peat having

accumulated at the surface in some areas generally in the southern half. The humus tends to be slightly sandy or silty. With the exception of Nebo Island, no large irregularities appear on the basin floor. The peat deposit does not completely encircle Nebo Island, but is missing on the east side (Figures 15 and 16).

Bog Five appears to have some of the characteristics of a climbing bog, but is probably a composite of both a climbing bog and a filled-basin bog. The surface is higher in the northeast quadrant, and the floor of the swamp does not have the relief that was found in most of the other bogs investigated. Furthermore, the peat becomes decidedly finer with depth, a characteristic of a climbing bog (Figure 16).

Reserves of harvestable peat in Bog Five are calculated to be 174,000 short tons.

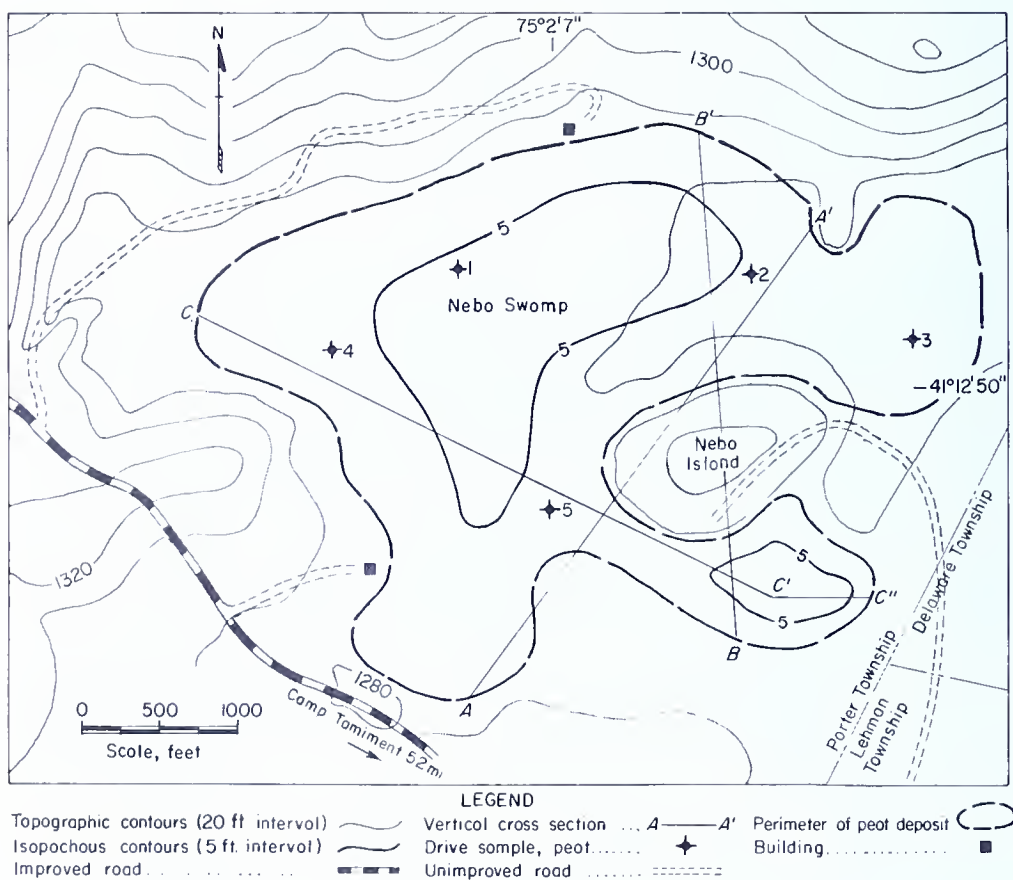


Figure 15. Isopach map of Bog Five with topography of surrounding terrain.

Table 8.—*Analyses of Peat Samples from Bog Five*

Sample No.	Depth	Percent Moisture Content ¹	Percent Ash Content ¹	Percent Organic Content ²	Percent Moisture Absorption ³	pH	Percent Fiber Content
1	4	92.6	0.8	6.6	1751	5.4	46.9
2	4	88.6	4.9	6.5	864	4.7	21.8
3	4	86.7	4.9	8.4	693	5.9	39.0
4	3	88.8	1.9	9.3	874	5.3	32.8
5	2	82.6	5.4	12.0	614	5.6	34.3

¹ As received.² Calculated.³ Dry basis.

Reed-sedge peat is the predominant type of peat in Bog Five. The relatively high pH makes it well suited for potting soil mixes for acid-intolerant plants, as well as for general soil improvement.

The underclay is hard and compact and is not continuous throughout the basin.

Draining of the bog would undoubtedly be difficult, though not impossible. Ditching for about 4,000 feet through the marshy area to the

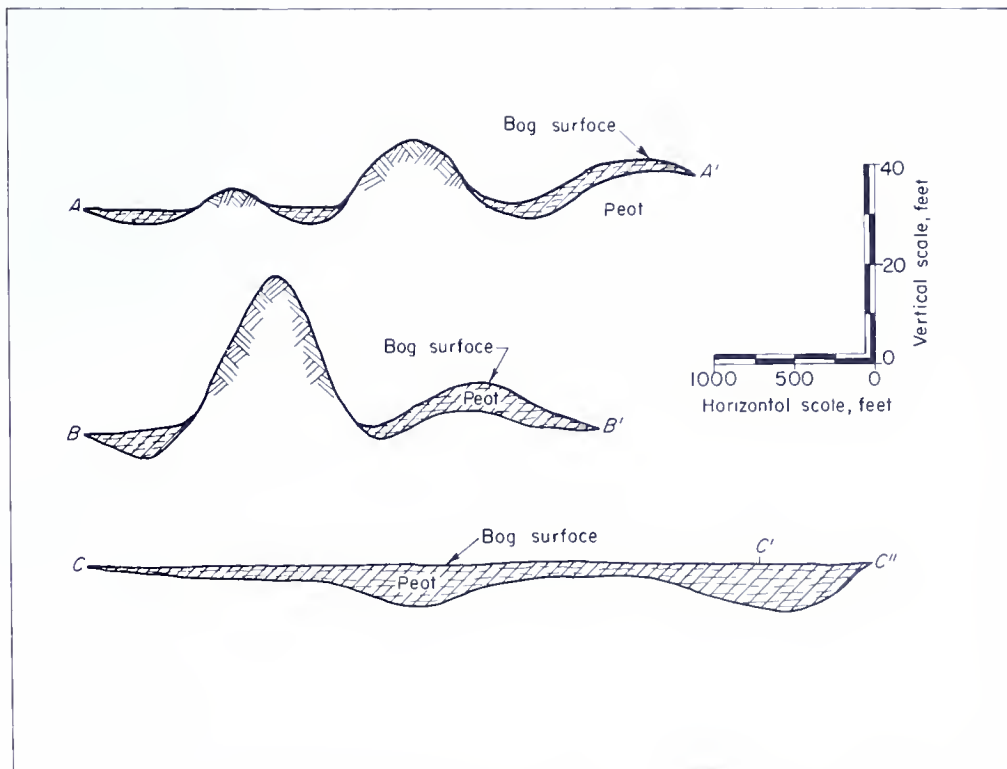


Figure 16. Vertical cross sections of Bog Five.

northwest would lead the outflow into Painted Swamp Creek, which empties into Little Bushkill Creek and subsequently into Mink Pond. The total distance between Bog Five and Mink Pond, following this course of drainage, is 2.7 miles and the gradient only 32 feet. From the southwest edge of Bog Five, a very small outflow (Figure 17) discharges into a marshy area. A ditch of about 8,500 feet would eventually drain the southwest half of the bog into Saw Creek Pond. The difference in elevation between Bog Five and Saw Creek Pond is about 305 feet. To ensure adequate drainage in a minimum of time, both methods should be employed.



Figure 17. Outflow of water from Bog Five.

BOG SIX

Bog Six (Figure 18) is an elongate swamp whose long axis trends approximately N. 80° E. The maximum length of the peat deposit is about 2,700 feet, and the maximum width about 1,300 feet. The bog covers approximately 53 acres; the center is located at 41° 37' 3" N. and 75° 43' 44" W. in Lackawanna County. The bog surface is about 1,150 feet above mean sea level. Occupying the north-central part of the bog is a small pond, known as Baylors Mud Pond, which covers approximately 4 acres.

Bog Six is shown on the U. S. Geological Survey's Dalton, Pa., quadrangle (7½-minute).



Figure 18. Dead surface vegetation on Bog Six.

The peat in Bog Six is largely reed sedge, although there are small amounts of peat humus found at the surface at scattered localities. A maximum peat thickness of 28 feet is present just south of Baylors Mud Pond. The average thickness throughout the bog is 10 feet. The contact between peat and underclay is distinct except in the extreme southern end of the bog. Here, the bottom foot of peat is decidedly clayey and often contains silt. In the central portion of the bog, at a depth of about 3 feet, is a thin layer of poorly decomposed woody material which is probably the residue of a buried forest.

Table 9.—*Analyses of Peat Samples from Bog Six*

Sample No.	Depth	Percent Moisture Content ¹	Percent Ash Content ¹	Percent Organic Content ²	Percent Moisture Absorption ³	pH	Percent Fiber Content
1	12	94.4	0.3	5.3	1533	5.5	44.4
2	3	90.7	1.9	7.4	1607	5.7	54.5
3	5	93.4	1.1	5.5	2067	5.7	56.2
4	5	94.0	0.8	5.2	1639	5.4	53.6
5	6	93.1	0.8	6.1	2055	5.5	51.9

¹ As received.

² Calculated.

³ Dry basis.

The peat in Bog Six is typical reed sedge. The relatively high pH makes this peat suitable for use in potting soil mixes for acid-intolerant plants and for general soil improvement.

The basin is characterized by two well-defined depressions, one centrally located and the other in the north-central portion. The most northerly of these depressions is by far the deepest, thus, it contains the greatest thickness of peat in the bog. The basin to the south has a maximum depth of 18 feet (Figures 19 and 20).

In a small area of the bog, about 100 feet across, near the east-central margin of the bog, the peat rests directly on rock. Elsewhere throughout the bog, underclay is present. The underclay is soft, light gray with occasional slight traces of red and is somewhat silty in the upper 3 feet. Below this, the clay becomes hard and compact. An evaluation of the underclay is given in the Appendix.

Reserves of harvestable peat in Bog Six are calculated to be 105,000 short tons.

Draining of Bog Six could be easily accomplished by deepening the natural drainage channel which leads southwestward from Bayers Mud Pond. The outflow would then be discharged into Lake Sheridan, a distance of about 7,500 feet. The difference in elevation between Bog Six and Lake Sheridan is approximately 160 feet.

BOG SEVEN

Bog Seven is an elongate swamp with a long axis slightly convex to the southeast. The approximate trend of the axis is N. 25° E. The maximum length of the peat deposit is 4,200 feet and the maximum width is 1,100 feet. The bog covers about 77 acres. Its approximate center is located at 41° 8' 15" N., and 76° 2' 15" W. in Luzerne County. The surface elevation of the peat deposit is 1,050 feet. Bog Seven is shown on the U. S. Geological Survey's Nanticoke, Pa., quadrangle (7½-minute). Paved roads are adjacent to both the southern and western edges of the bog.

A perched water table (Figure 21) caused by the blockage of a culvert at the western end of the bog necessitated traversing by canoe. Precise measurements of distance between probing and sampling points were thus difficult to obtain. Approximate locations of these stations were obtained both by visual orientation and by compass bearings taken on known features around the periphery of the bog.

The maximum thickness of peat in Bog Seven is 22 feet. This is found in a depression in which the deepest part is located approximately 1,200 feet east of the western edge of the peat deposit. The average thickness of peat throughout the bog is 7 feet. The basin itself is characterized

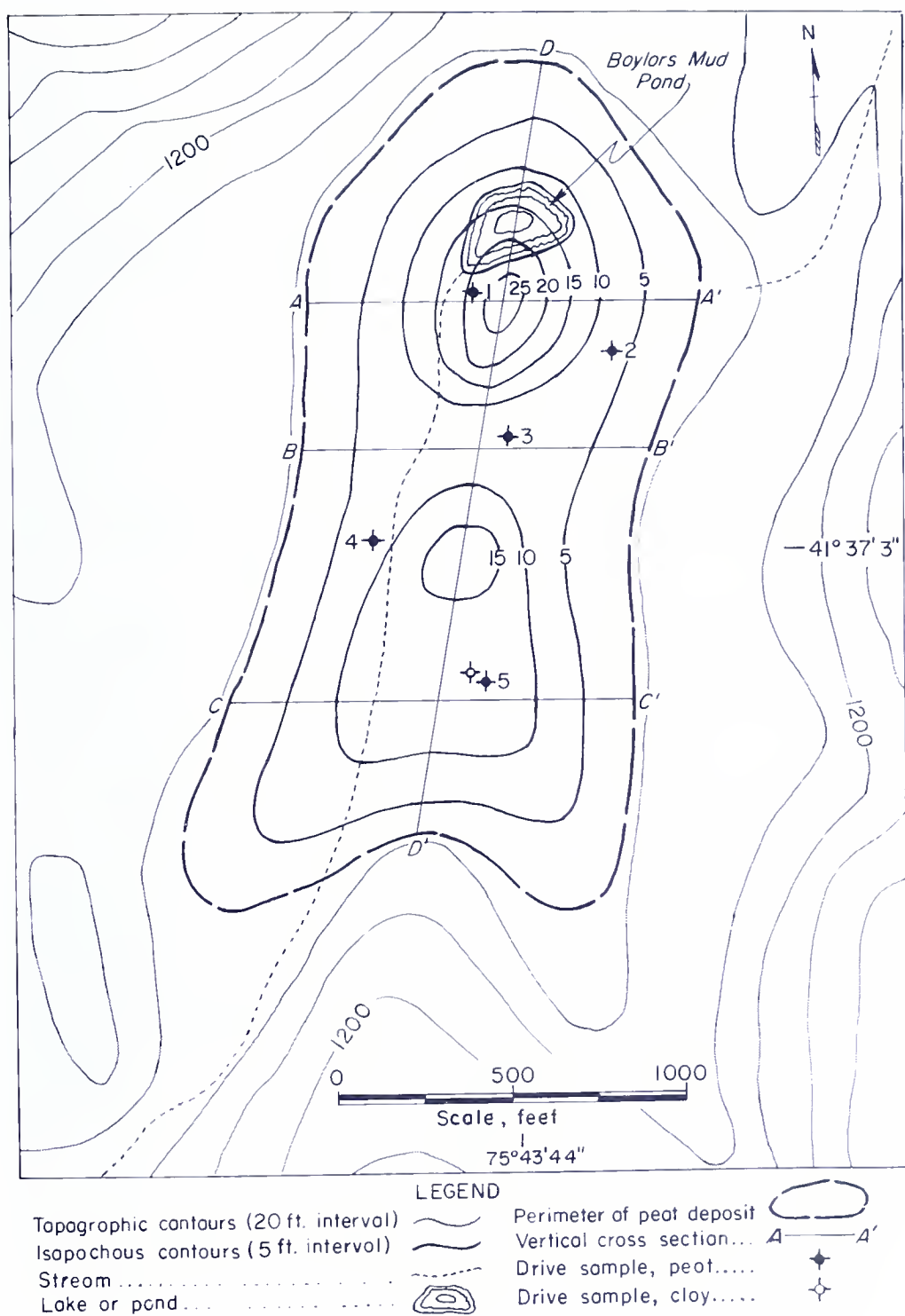


Figure 19. Isopach map of Bog Six with topography of surrounding terrain.

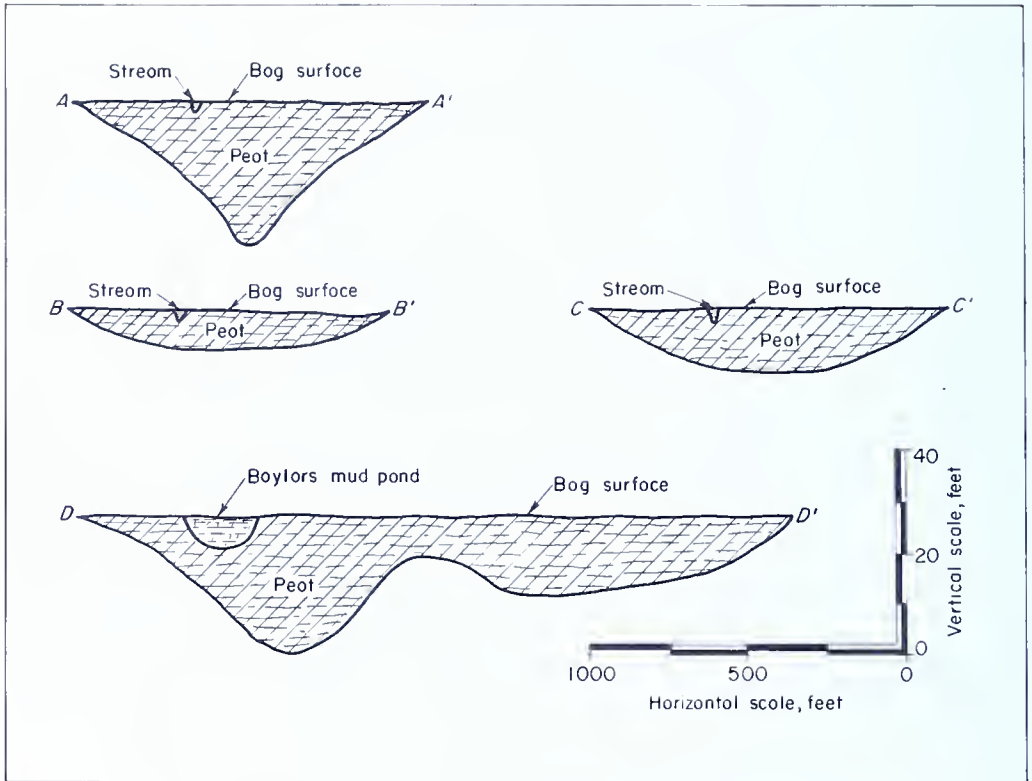


Figure 20. Vertical cross sections of Bog Six.



Figure 21. Bog Seven showing perched water table.

by north-south symmetry. East-west symmetry is precluded by two depressions in the basin floor, one of which is mentioned above. The second depression is centrally located and contains a maximum peat thickness of 12 feet (Figures 21 and 22).

The peat in Bog Seven is largely reed sedge and is generally overlain by about 1 foot of muck. Over the elevated portion of the basin floor which separates the two depressions, the peat contains a considerable amount of poorly decomposed woody material throughout its thickness.

Reserves of harvestable peat in Bog Seven are calculated to be 108,000 short tons.

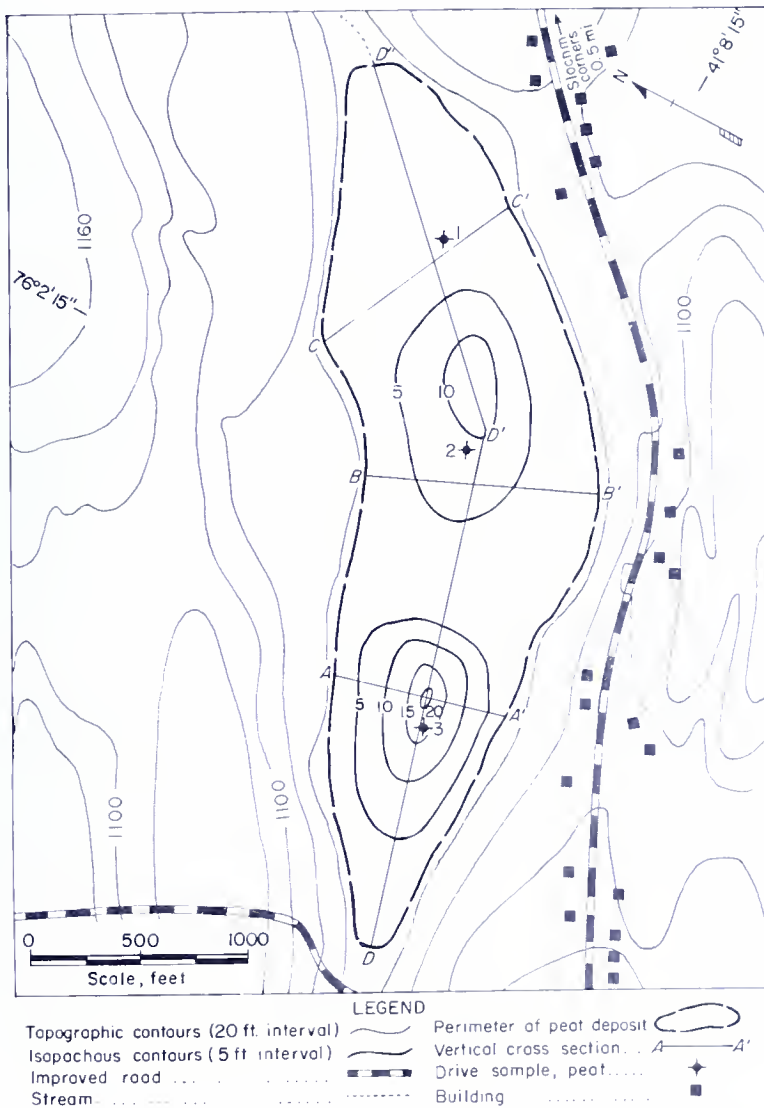


Figure 22. Isopach map of Bog Seven with topography of surrounding terrain.

Table 10.—*Analyses of Peat Samples from Bog Seven*

Sample No.	Depth	Percent Moisture Content ¹	Percent Ash Content ¹	Percent Organic Content ²	Percent Moisture Absorption ³	pH	Percent Fiber Content
1	4	90.6	0.8	8.6	1487	5.6	42.1
2	2	94.3	0.4	5.3	2700	5.2	50.5
3	9	89.8	1.6	8.6	1125	5.5	39.4

¹ As received.
² Calculated.
³ Dry basis.

The reed-sedge peat in Bog Seven has a relatively high pH which makes it suitable for general soil improvement purposes and for use in potting soil mixes for acid-intolerant plants.

A soft to hard, light-gray to pinkish-gray underclay is present throughout the bog. Near the central part of the bog the underclay is either slightly silty or sandy.

Bog Seven could be easily drained by opening the presently blocked culvert at the western end. The discharge would then flow into Pond Creek, a distance of about 2.9 miles. The difference in elevation between the bog and the point of discharge into Pond Creek is 225 feet.

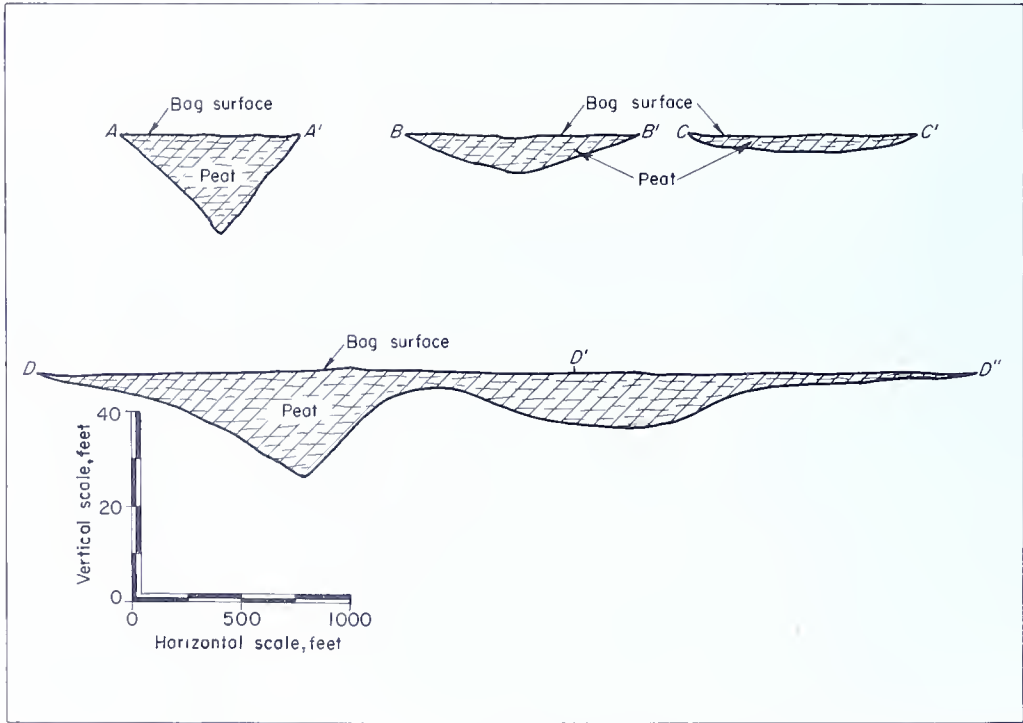


Figure 23. Vertical cross sections of Bog Seven.

BOG EIGHT

Bog Eight (Figure 24) is an elongate, submerged swamp whose long axis trends approximately N. 40° W. The maximum length of the peat deposit is about 5,600 feet, and the maximum width is 1,500 feet. The peat surface is about 1,910 feet above mean sea level, and the approximate center of the bog is located at $41^{\circ} 18' 5''$ N. and $75^{\circ} 24' 24''$ W. in Wayne County.

Bog Eight is shown on the U. S. Geological Survey's Sterling, Pa., quadrangle (7½-minute) and the Ariel, Pa. quadrangle (15-minute).

The peat in Bog Eight is reed sedge and humus and has a maximum thickness of 11 feet. The average thickness throughout the bog is 6 feet. The bottom foot or more of peat is almost always clayey. Generally, the peat contains little undecomposed material.

Reserves of harvestable peat in Bog Eight are calculated to be 145,000 short tons.



Figure 24. Bog Eight showing perched water table.

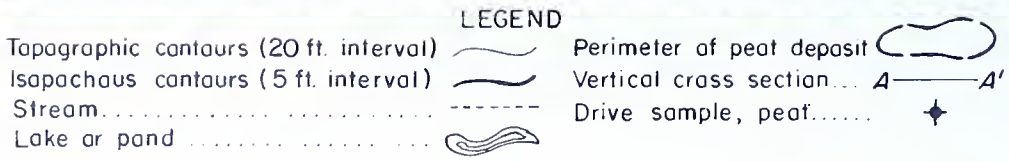
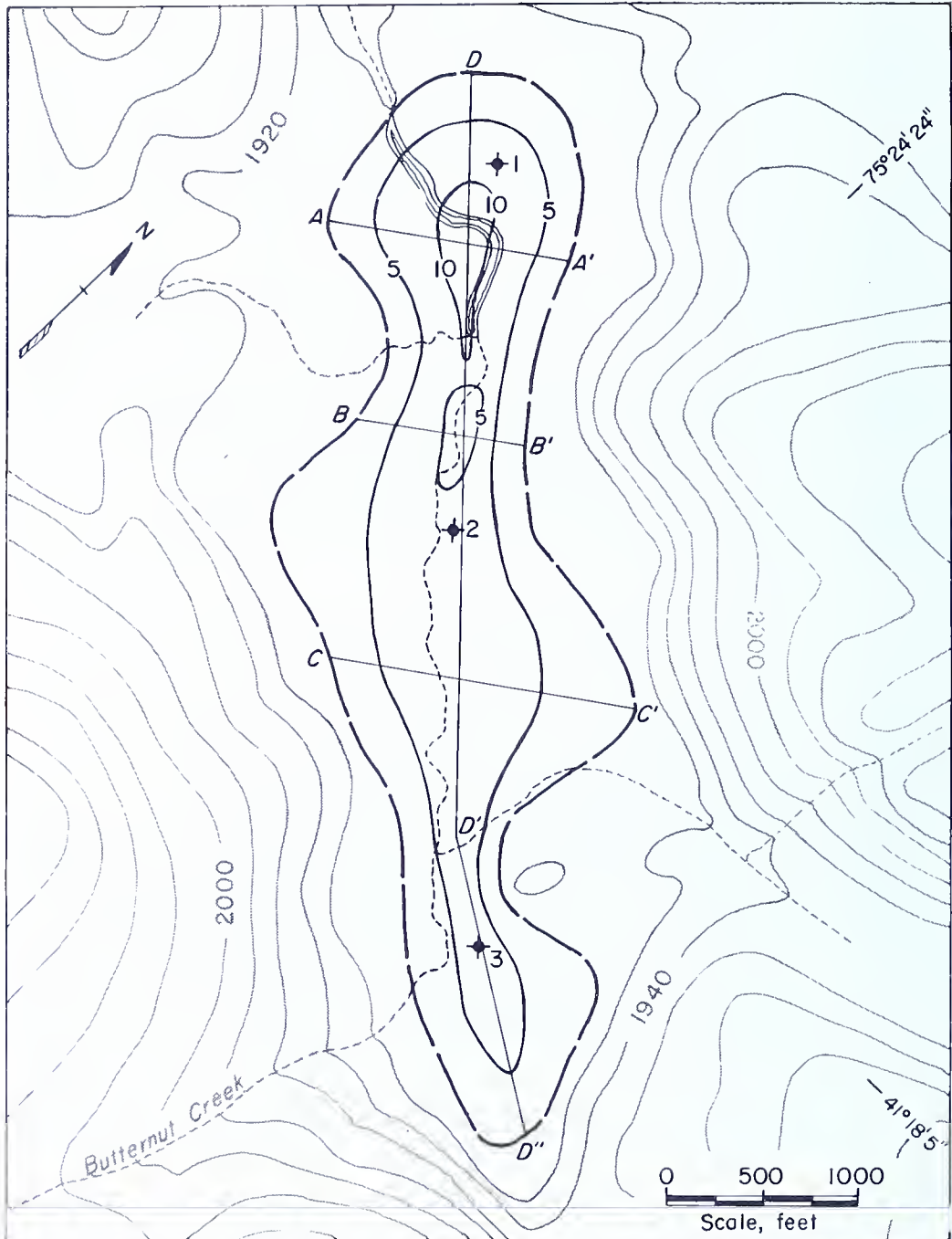


Figure 25. Isopach map of Bog Eight with topography of surrounding terrain.

Table 11.—*Analyses of Peat Samples from Bog Eight*

Sample No.	Depth	Percent Moisture Content ¹	Percent Ash Content ¹	Percent Organic Content ²	Percent Moisture Absorption ³	pH	Percent Fiber Content
1	2	85.9	1.0	13.1	1047	5.3	26.8
2	6	92.0	3.6	4.4	1258	5.1	53.1
3	5	90.7	0.7	8.6	1378	5.4	48.2

¹ As received.² Calculated.³ Dry basis.

Reed-sedge peat is the predominant peat variety in Bog Eight. It is used principally for general soil improvement and potting soil mixes for acid-intolerant plants.

The basin is characterized by a relatively shallow depression in the northwest end which contains the bog's maximum thickness of peat. Immediately southeast of this depression the peat thins over a slight protuberance, probably glacial drift. Other than these two irregularities, the basin floor slopes rather uniformly from the edges toward the long axis (Figures 25 and 26).

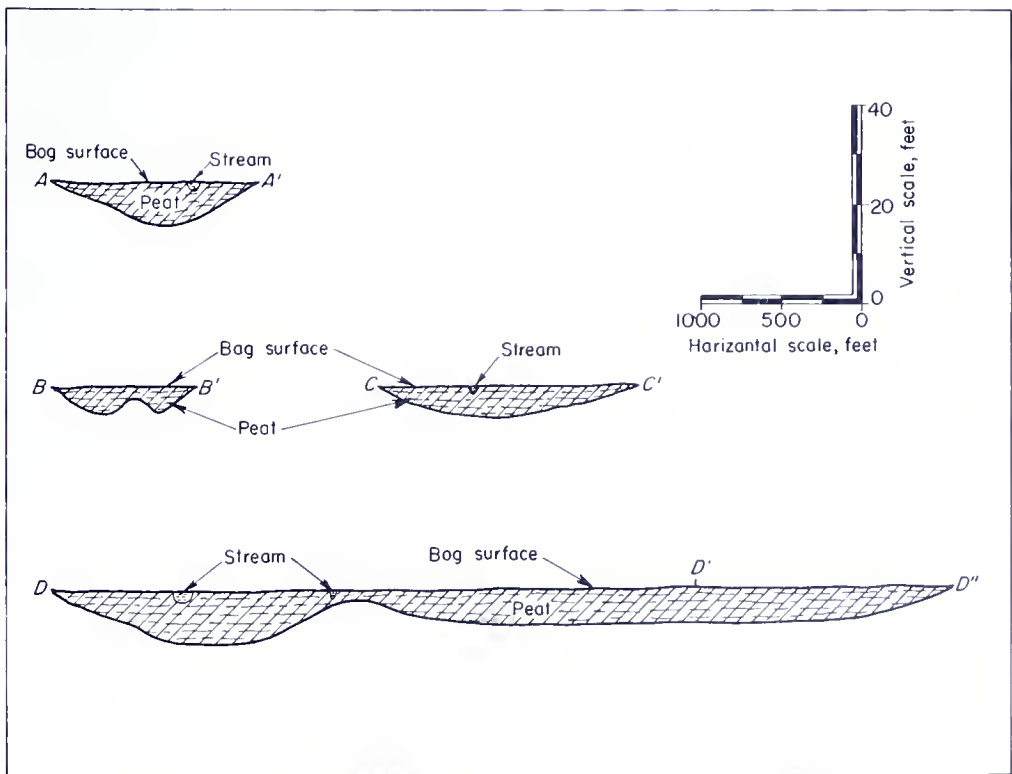


Figure 26. Vertical cross sections of Bog Eight.

Underclay is present throughout the basin. In most places it is light gray, soft, and very silty in the upper 4 to 9 feet. This appears to be genetically unrelated to the clay beneath, which is dark gray, hard, and compact.

Butternut Creek is the natural drainage of Bog Eight but would require deepening to adequately drain the swamp. The gradient to the northwest is sufficiently steep to ensure drainage.

BOG NINE

Bog Nine is an elongate swamp with a long axis trending N. 12° E. The maximum length of the peat deposit is 2,900 feet, and the maximum width is 1,200 feet. In area, the bog covers about 66 acres. Surface elevation is 1,195 feet above mean sea level. The approximate center of the bog is located at 41° 37' 33" N. and 75° 41' 28" W. in Lackawanna County.

The northern portion of Bog Nine is shown on the U. S. Geological Survey's Lenoxville, Pa., quadrangle (7½-minute); the southern portion is on the Dalton, Pa., quadrangle (7½-minute).

The peat in Bog Nine is predominantly of the reed-sedge variety and has a maximum thickness of 42 feet. The bottom few feet of peat contain a considerable amount of clay, are often silty or sandy, and in places, contain sandstone pebbles up to ¼ inch in diameter. The upper part of the peat deposit is well decomposed and clean and is comprised of considerable peat humus. The average thickness of peat throughout the bog is 16 feet.

Reserves of harvestable peat in Bog Nine are calculated to be 210,000 short tons.

Table 12.—*Analyses of Peat Samples in Bog Nine*

Sample No.	Depth	Percent	Percent	Percent	Percent	pH	Percent
		Moisture Content ¹	Ash Content ¹	Organic Content ²	Moisture Absorp- tion ³		Fiber Content
1	10	93.3	0.7	6.0	2381	5.7	48.4
2	8	87.9	5.9	6.2	759	5.4	32.6
3	14	93.2	1.4	5.4	1641	5.8	44.2
4	1	83.8	6.4	9.7	760	6.1	34.6

¹ As received.

² Calculated.

³ Dry basis.

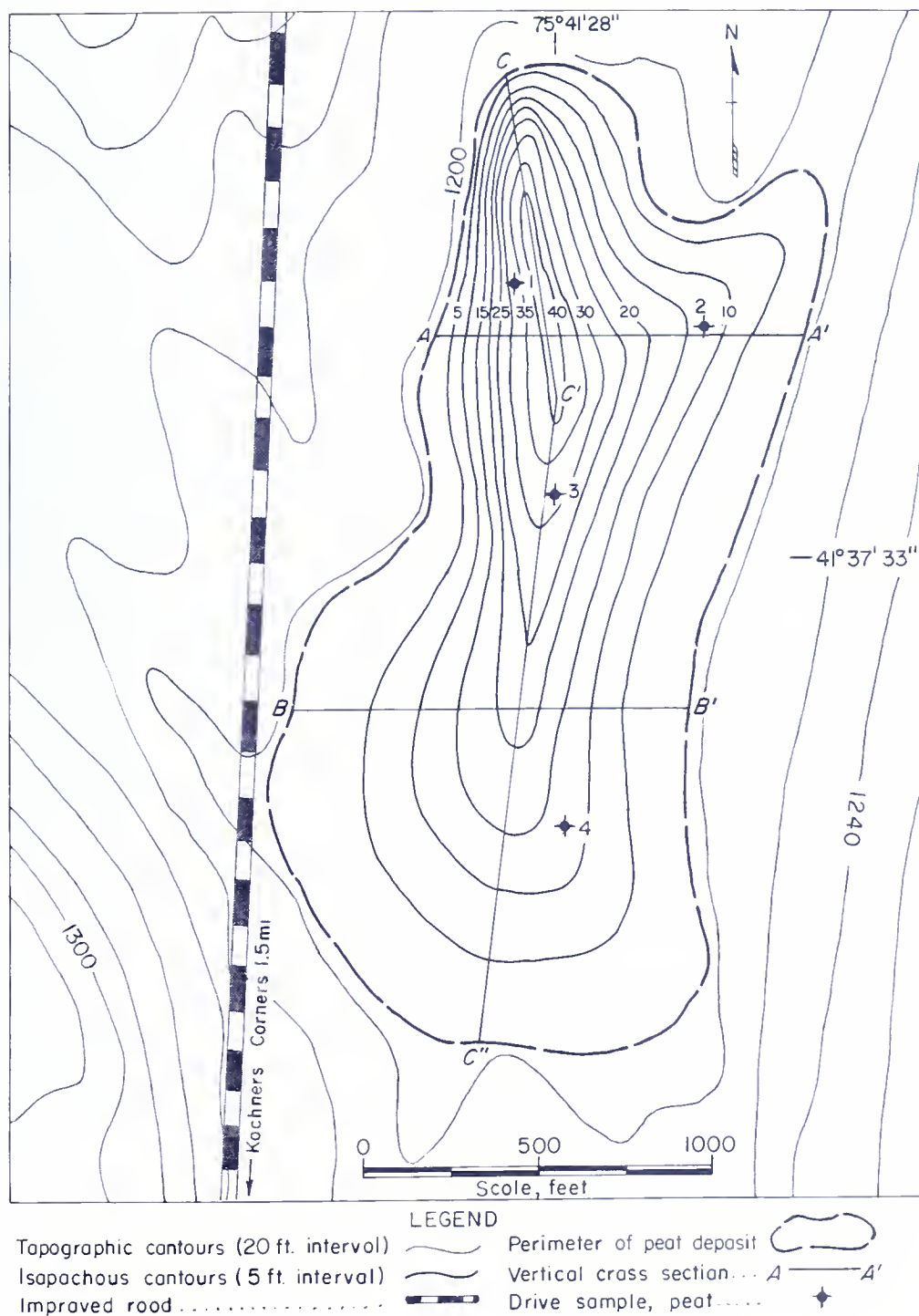


Figure 27. Isopach map of Bog Nine with topography of surrounding terrain.

Reed-sedge peat is the predominant peat variety in Bog Nine, but there is, however, some harvestable peat humus. Both types are suitable for general soil improvement and for potting soil mixes for acid-intolerant plants. Peat humus is also a fairly good source of nitrogen.

The basin attains its maximum depth in the northwest quadrant. Outward from this point the floor slopes upward rather uniformly to the edges (Figures 27 and 28). No major irregularities on the basin floor were found.

The underclay, which is present throughout the bog, is light gray, sandy or silty and varies from very soft to hard and compact. In many areas of the bog, the contact between peat and clay is indistinct.

The natural drainage of Bog Nine is to the northeast, where a small stream flows through a marshy area and subsequently discharges into the East Branch of Tunkhannock Creek. The total distance from the northeastern edge of the bog and the point of discharge into Tunkhannock Creek is about 1.9 miles; the difference in elevation is 365 feet.

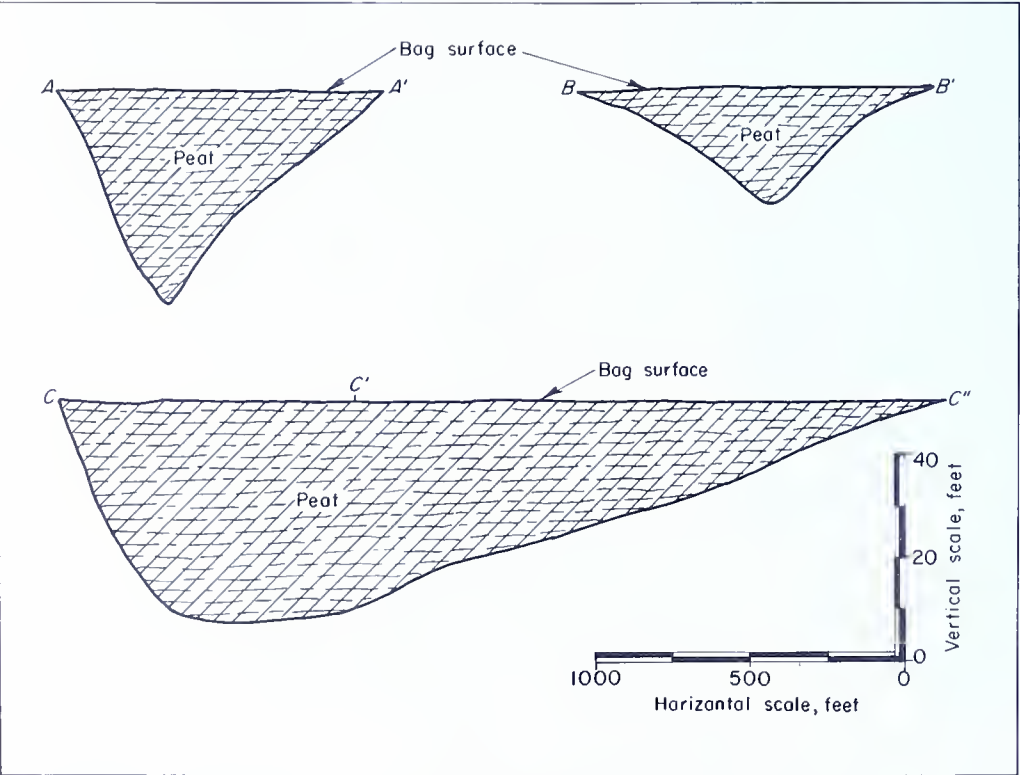


Figure 28. Vertical cross sections of Bog Nine.

PEAT-HARVESTING METHODS

The harvesting, or winning, of peat is done by a variety of methods. The choice of method depends upon the type of peat contained in the bog, the nature of the bog, the areal extent of the peat deposit, the quantity of harvestable reserves available, and the yearly tonnage desired.

In most active peat-bog operations in northeastern Pennsylvania, the peat is harvested with simple farm-type equipment and small earthmoving units equipped with wide tracks. It is mandatory in any peat-harvesting operation to keep the initial investment low and operating costs to the minimum. The method of harvesting peat described as follows is suggested as being suitable for the bogs discussed in this report.

Peat harvesting comprises three distinct operational phases: (1) clearing the bog surface, (2) draining, and (3) harvesting. Clearing and draining are usually undertaken simultaneously.

CLEARING AND DRAINING

Clearing of a peat bog entails the removal of all trees, stumps, low surface vegetation, and roots, and leveling the surface insofar as is practical. It is unlikely that any of the bogs explored offer a surface stable enough in the summer to permit clearing with a bulldozer. The winter months, when the bog surface is frozen, is the most practicable time for clearing.

The clearing of a bog should begin at a point from which the main drainage ditch will lead and follow the ditch line. Thus, as clearing progresses, excavation of the drainage ditch can begin whenever surface conditions of the bog permit. The draining of a peat bog has two desirable results: (1) the bog becomes more compact and ultimately permits the use of harvesting equipment and hauling units directly on the surface, and (2) considerably less weight is handled with corresponding cost savings.

Perhaps the most suitable equipment for excavating the main ditches is a dragline or backhoe mounted on a small crawler tractor. At first, the excavating equipment must be operated from mats in order to keep the bearing pressure low (Figure 29). An alternative to the use of mats is to construct a roadway from timber and brush that has been cleared from the bog or bog approaches. If sufficient material is used and properly compacted, the roadway can be used in hauling excavated peat from the bog. The sides of the main ditch must be sloped at an angle less than the angle of repose of the wet peat so that the ditch will not collapse. Generally an initial depth of 5 feet for the main ditch is adequate to initiate drainage of the bog.



Figure 29. Crawler-mounted dragline operating on wooden mats.

As draining and clearing of the bog surface progresses, additional ditches are excavated parallel to each other and spaced about 500 feet apart. These main ditches are then cross-connected with a series of smaller trenches, usually not more than a foot wide, but as deep as the main ditches. Both ditches and trenches must be deepened as the upper portions of the bog drain and become compact. Trenches should be perpendicular to the main ditches and should be spaced about 50 feet apart. If adequate drainage is not achieved, then additional trenches are excavated. Trenching is ideally done with small farm-type trenchers which are relatively inexpensive. It may be necessary to trench each year for the first few years of operation.

Individual circumstances might warrant the contracting of ditching, which requires more expensive equipment than does trenching. Furthermore, it is usually not necessary to ditch as often as it is to trench.

It is important not to completely drain a bog. Peat has an optimum moisture content of between 55 and 65 percent. Complete draining may result in the breakdown of the cellular structure of the peat, and thus reduce its value as a soil conditioner. Furthermore, complete drainage increases the possibility of a bog fire. Control of water flowing from a bog is easily done through the use of gates at the ends of main drainage ditches.

All power-driven equipment used on the surface of a bog should be exhausted upward as a fire-preventive method. Insofar as is practical, the equipment should also be well balanced to provide even weight distribution along bearing surfaces.

After the bog has been cleared and drained to the point where surface stability permits the operation of tractors on the bog, all low brush and roots must be removed. Conventional scarifiers pushed by small tractors equipped with wide tracks are the most suitable for brush and root removal. The material removed by grubbing is stacked into piles and burned. Burning is best done in the winter when the surface of the bog is frozen, and preferably when there is snow on the ground. This precludes the possibility of a bog fire. To facilitate harvesting the peat, all large roots and most of the smaller roots should be removed. Since grubbing is a one-time process, consideration should be given to contracting this work.

Pollution

Pollution of natural drainage by the water flowing from a peat bog is seldom a serious factor. Although swamp water often has a relatively low pH, this is largely the result of humic acid which is a normal component of many streams. However, sudden large surges of water from a draining bog should be avoided, particularly during stages of low stream flow. Otherwise, dilution by the stream may not be sufficient to prevent fish kills.

Bog drainage is regulated by the Pennsylvania Department of Health, Division of Sanitary Engineering. Potential operators of bogs should seek advice from this agency before attempting drainage.

HARVESTING

Harvesting, or winning, of peat from a bog can commence as soon as the surface is cleared and is firm enough to support small earthmoving equipment. Small tractors with wide tracks are generally used for operations across the bog surface.

Harrowing

The initial phase of peat harvesting is harrowing. A double-disc harrow equipped with 14 to 16-inch discs is recommended for use in the bogs. A tractor of about 20 hp and equipped with wide tracks is adequate to pull the harrow. Harrowing should not exceed 5 inches in depth. Harrowing to greater depths results in excessive oxidation and drying of the peat and thus a greater danger of bog fires.

After harrowing, the loosened peat is allowed to air-dry to a moisture content of about 60 percent before it is collected. The time required depends entirely upon local weather conditions, but generally, about two weeks is adequate. The size of the area harrowed should not be too large to permit collection of the peat before drying exceeds 60 percent moisture. For bogs the size of those in the area investigated, about 20 acres is the maximum area that can be adequately handled at one time.

Windrowing

When the harrowed peat has air-dried sufficiently, it may be piled into windrows to facilitate collection. A satisfactory windrower is most economically constructed at the bog. The windrower is a simple V-shaped wooden or metal wedge equipped with a three-gang hitch for pulling behind the tractor. Parallel rows of peat are thus built up at either end of the windrower. Windrowing should be continued until all the previously loosened peat is removed from the harrowed area and that portion of the bog again presents a firm surface for subsequent harrowing.

TRANSPORTATION TO STOCKPILE

Small bulldozers (preferably equipped with U-shaped blades) may be used to move the windrowed peat to the nearest point of the road where the peat can be loaded into dump trucks by a front-end loader, power shovel, or clamshell. Two 2-ton dump trucks have adequate capacity to handle a steady flow of peat from the bog to the processing facilities when they are loaded with a bucket not exceeding 1.5 cubic yards in capacity. The loaded trucks dump the peat at a central stockpile adjacent to the processing facilities. The trucking of peat from the bog to the central stockpile might be contracted.

PROCESSING OF PEAT

The processing of peat involves screening, shredding, weighing, and packaging. Occasionally, drying by artificial methods is employed (usually in oil- or gas-fired kilns), but in northeastern Pennsylvania, this is unnecessary and would only add to processing costs. For reasons of economy, processing facilities should be simple, have the capability of producing a continuous flow of processed peat, and be maintained easily.

The following description is of a two-line processing plant capable of producing a maximum of 20,000 short tons per year of processed, packaged peat. Usually, all the peat harvested from a bog is not sold in processed, packaged form. A considerable quantity of the bog output

is often sold as processed, bulk peat. Occasionally, smaller quantities are sold as unprocessed, bulk peat.

By drawing from the central stockpile, processing can continue throughout the winter months in order to build inventory for early spring sales.

Figure 30 is a flow diagram of a two-line peat processing plant suitable for processing peat from northeastern Pennsylvania bogs.

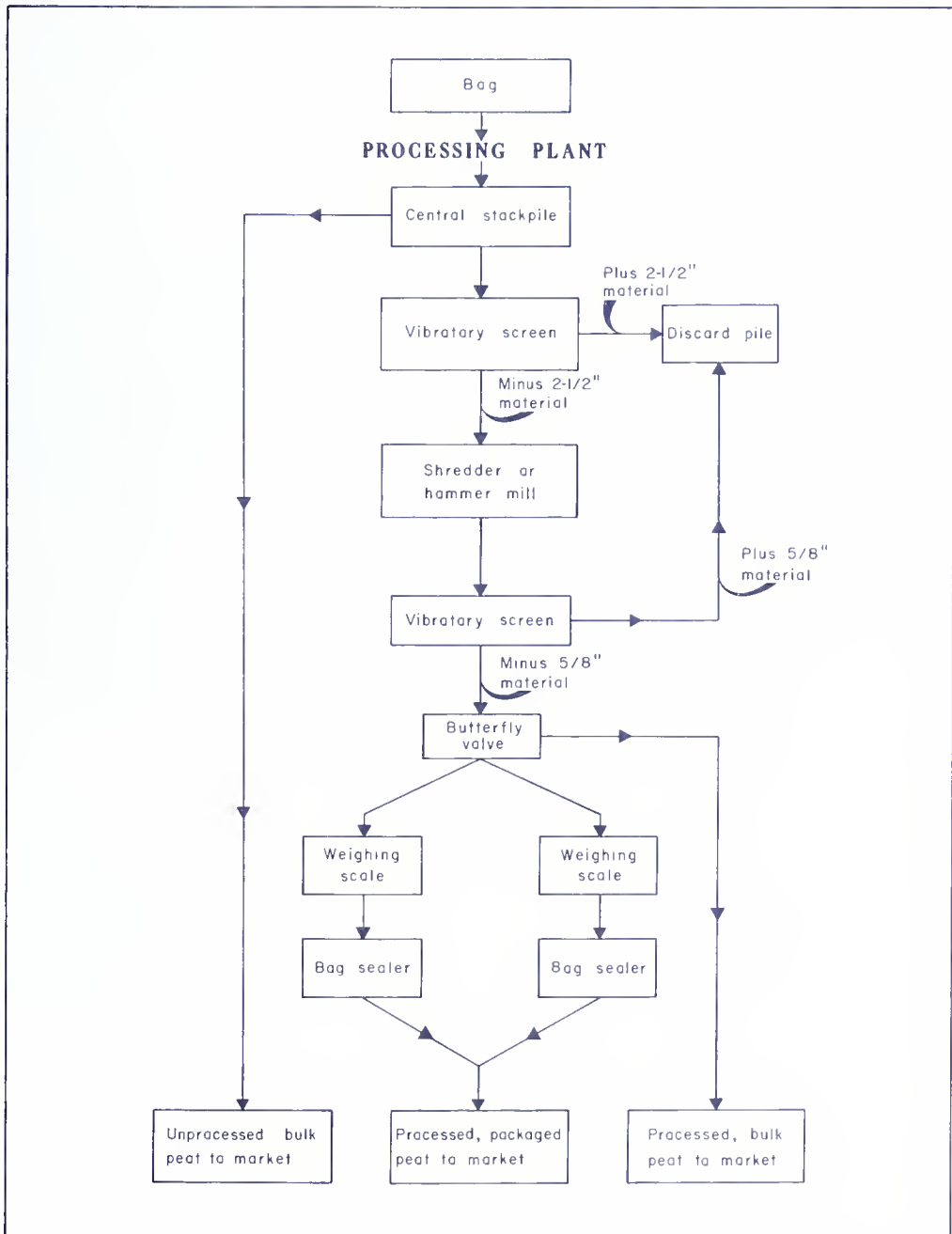


Figure 30. Flow diagram of a two-line processing plant.

From the central stockpile, the peat is fed by front end loader, clam-shell, power shovel, or conveyor, into a hopper, where it flows by gravity onto a vibrator screen with 2.5-inch openings. Material which will not pass the screen is removed by conveyor to a discard pile. The peat which passes the screen is fed to a shredder or hammer mill. The milled peat then passes over a second vibrator screen with either $\frac{1}{2}$ - or $\frac{5}{8}$ -inch openings. The material which fails to pass this screen also goes by conveyor to the discard pile. With suitable arrangement of equipment, the same conveyor can be utilized to transport the discard from both screening operations.

Following the second screening, the peat flows by gravity to a hopper equipped with a butterfly valve from which two pipes lead to two weighing scales.

Bagging and weighing are done manually by a man stationed at each scale. The control for the butterfly valve is positioned for operation by either man. The flow of peat is directed through one pipe until a bag is filled to the predetermined weight. The butterfly valve is then operated to direct the flow of peat into the second pipe and thus into another bag. Bags are carried alternately by conveyor from the weighing scales to a bag sealer.

The two-line method of weighing and packaging permits a continuous flow of peat through the processing facilities.

Often, orders will be received for processed, bulk peat. In this case the weighing and bagging operations are bypassed and the peat is carried by conveyor directly from the second screening operation into trucks. Rarely, orders for unprocessed bulk peat can be expected. In this case, the material is drawn directly from the central stockpile.

MARKETING

The marketing area for peat produced from northeastern Pennsylvania bogs consists principally of the Scranton—Wilkes-Barre—Hazleton—Stroudsburg area and also the Atlantic Seaboard States. The primary competition will come from peat shipped in from the New England States, from Michigan, Indiana, and Minnesota, and from Canada. It would be difficult to determine the interstate movement of peat because peat is an exempted commodity from the list of those sampled by the Interstate Commerce Commission. However, peat producers generally agree that the principal source of peat entering the Atlantic Seaboard market is Michigan, which produces more than any of the other states. Canadian peat also competes in this market and imports will undoubtedly increase. Reed-sedge peat produced in Pennsylvania cannot compete in Canada

because of a $33\frac{1}{3}$ percent duty imposed. In most of the marketing areas transportation rates will favor peat produced in northeastern Pennsylvania, especially if the trucker can backhaul.

A prime marketing area exists in northeastern Pennsylvania alone. In addition to urban areas, the Pocono Mountain region is the site of innumerable tourist resorts, many of which maintain their own golf courses and have extensive lawns and gardens. Locally-produced peat should find ready acceptance by these resorts.

Peat may also be sold in the Delaware Water Gap National Recreation Area, now being developed. The project is expected to be completed in 1977, but resort building will undoubtedly continue for some time after that.

Peat is sold directly by producers to retail outlets, through manufacturer's representatives and jobbers, and often to consumers as well. Peat operations capable of producing large yearly tonnages of packaged peat generally sell most of their output to retail chains such as groceries and department stores. Farm-equipment stores, nurseries, greenhouses, and garden-supply stores also buy processed, packaged peat either directly from producers or from wholesalers.

Processed, bulk peat is sold by truckload or carload directly to government agencies, construction projects such as housing or park developments, cemeteries, mushroom growers, and firms which blend or mix special types of soils, mulches, and fertilizers. Occasionally the latter will buy unprocessed bulk peat direct from the central stockpile.

The average peat operation in Pennsylvania produced less than 4,000 short tons in 1966. Operations of this size cannot supply the demand of large retail chains. Therefore, most of their output presently goes to individual retail stores, local government agencies, and directly to consumers. Newspaper advertising is frequently employed. Several trade journals are available which contain lists of construction projects which require peat.

Reed-sedge peat, the type most common in northeastern Pennsylvania, is sold in bags of 25, 50, and 100 pounds. All packaged peat is processed. About 90 percent of the packaged peat is sold in 50 pound polyethylene bags.

Humus, also produced from some bogs in northeastern Pennsylvania, is sold in bags of 50 to 100 pounds.

Moss peat, of which there is but a negligible amount produced in Pennsylvania, is usually sold in bulk.

In general, there appears to be no major obstacle which would create abnormal competition to the sale of peat produced in northeastern Pennsylvania in either local markets or those along the Atlantic Seaboard.

CONCLUSIONS

Of the nine peat bogs investigated, all appear to be capable of commercial exploitation. The character of the bogs is such that no insurmountable obstacle stands in the way of either draining or harvesting, although draining of some of the bogs may be time-consuming.

The harvesting and processing of peat are both relatively simple operations and require a minimal capital investment considering the harvestable reserves of peat in each bog.

One bog contains an underclay which might be used in the manufacture of face brick, and thus provide additional income.

Peat produced from any of the bogs can readily compete in local markets and in those along the Atlantic Seaboard.

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APPENDIX

EVALUATIONS OF CLAY SAMPLES FROM PEAT BOGS

BOG ONE

Sample Number: One.

Location: 41° 15' 33" N.; 75° 32' 7" W. Moscow, Pa., quadrangle (7½-minute).

Description of Material: Soft, light-gray clay, slightly sandy.

Raw Properties: Water of plasticity, 57.5 percent; working properties, low plasticity; drying defects, none; drying shrinkage, 5.0 percent; dry strength, low.

Slow-firing Test

<i>Temperature °F</i>	<i>Color</i>	<i>Mohs' hardness¹</i>	<i>Total shrinkage, percent</i>	<i>Absorption, percent</i>	<i>Apparent porosity, percent</i>	<i>Bulk density, g/cu cm</i>
1,800	Tan	Poor bond	7.5	50.0	55.5	1.11
1,900	Tan	2	10.0	36.6	47.6	1.30
2,000	Light brown	4	17.5	18.9	31.4	1.66
2,100	Dark brown	5	25.0	1.2	26.2	2.18
2,200	—	—	Expanded	—	—	—
2,300	—	—	—	—	—	—

¹In clay evaluation terminology, the term "poor bond" is used to designate materials whose hardness is less than 2 on the Mohs' scale of hardness.

Bloating Test: Negative.

Other Tests: pH, 4.6. Not effervescent in HCl.

Remarks: Low dry strength. High firing shrinkage. Abrupt vitrification.

Potential Use: Not suitable for use in vitreous clay products.

Note: The data presented here are based on laboratory tests that are preliminary in nature and will not suffice for plant or process design.

BOG TWO (BIG SWAMP)

Sample Number: One.

Location: 41° 11' 43" N.; 75° 5' 42" W. Twelvemile Pond quadrangle (7½-minute).

Description of Material: Soft, light-gray clay contaminated with peat.

Raw Properties: Water of plasticity, 34.8 percent; working properties, low plasticity; drying defects, none; drying shrinkage, 2.5 percent; dry strength, low.

Slow-firing Test

<i>Temperature °F</i>	<i>Color</i>	<i>Mohs' hardness¹</i>	<i>Total shrinkage, percent</i>	<i>Absorption, percent</i>	<i>Apparent porosity, percent</i>	<i>Bulk density, g/cu cm</i>
1,800	Tan	Poor bond	—	—	—	—
1,900	Tan	Poor bond	—	—	—	—
2,000	Brown	Poor bond	—	—	—	—
2,100	Brown	Poor bond	—	—	—	—
2,200	Brown	Poor bond	—	—	—	—
2,300	Gray	2	17.5	43.8	52.5	1.20

¹ In clay evaluation terminology, the term "poor bond" is used to designate materials whose hardness is less than 2 on the Mohs' scale of hardness.

Bloating Test: Negative.

Other Tests: pH, 7.8. Not effervescent in HCl.

Remarks: Low green strength. Poor ceramic bond.

Potential Use: Not suitable for use in vitreous clay products.

Note: The data presented here are based on laboratory tests that are preliminary in nature and will not suffice for plant or process design.

BOG TWO (BIG SWAMP)

Sample Number: One (calcined).

Location: 41° 11' 43" N.; 75° 5' 42" W. Twelvemile Pond quadrangle (7½-minute).

Description of Material: Soft, light-gray clay. Calcined at 450° F. in an attempt to burn out peat contamination.

Raw Properties: Water of plasticity, 38.7 percent; working properties, low plasticity; drying defects, none; drying shrinkage, 0.0 percent; dry strength, low.

Slow-firing Test

<i>Temperature °F</i>	<i>Color</i>	<i>Mohs' hardness¹</i>	<i>Total shrinkage, percent</i>	<i>Absorption, percent</i>	<i>Apparent porosity, percent</i>	<i>Bulk density, g/cu cm</i>
1,800	Tan	Poor bond	—	—	—	—
1,900	Tan	Poor bond	—	—	—	—
2,000	Tan	Poor bond	—	—	—	—
2,100	Brown	Poor bond	—	—	—	—
2,200	Brown	4	7.5	27.7	39.3	1.42
2,300	Gray	5	10.0	19.2	30.3	1.58

¹ In clay evaluation terminology, the term "poor bond" is used to designate materials whose hardness is less than 2 on the Mohs' scale of hardness.

Bloating Test: Negative.

Other Tests: None.

Remarks: Low green strength. Poor ceramic bond.

Potential Use: Not suitable for use in vitreous clay products.

Note: The data presented here are based on laboratory tests that are preliminary in nature and will not suffice for plant or process design.

BOG THREE (ROBINSON LAKE)

Sample Number: One.

Location: 41° 40' 40" N.; 75° 40' 49" W. Lenoxville, Pa., quadrangle (7½-minute).

Description of Material: Soft, light-gray clay, slightly silty.

Raw Properties: Water of plasticity, 28.4 percent; working properties, low plasticity; drying defects, none; drying shrinkage, 0.0 percent; dry strength, low.

Slow-firing Test

<i>Temperature °F</i>	<i>Color</i>	<i>Mohs' hardness¹</i>	<i>Total shrinkage, percent</i>	<i>Absorption, percent</i>	<i>Apparent porosity, percent</i>	<i>Bulk density, g/cu cm</i>
1,800	Tan	Poor bond	—	—	—	—
1,900	Tan	2	2.5	30.3	42.1	1.39
2,000	Tan	2	5.0	28.1	40.5	1.44
2,100	Reddish brown	4	7.5	19.4	31.4	1.62
2,200	Dark brown	4	10.0	14.6	25.1	1.72
2,300	Dark brown	5	12.5	3.3	5.8	1.75

¹ In clay evaluation terminology, the term "poor bond" is used to designate materials whose hardness is less than 2 on the Mohs' scale of hardness.

Bloating Test: Negative.

Other Tests: pH, 6.7. Not effervescent in HCl.

Remarks: Low green strength.

Potential Use: Might possibly be used as a nonplastic in face brick mixtures.

Note: The data presented here are based on laboratory tests that are preliminary in nature and will not suffice for plant or process design.

BOG THREE (ROBINSON LAKE)

Sample Number: One (calcined).

Location: 41° 40' 40" N.; 75° 40' 49" W. Lenoxville, Pa., quadrangle (7½-minute).

Description of Material: Soft, light-gray underclay, slightly silty. Calcined at 450° F in an attempt to burn out peat contamination.

Raw Properties: Water of plasticity, 32.3 percent; working properties, low plasticity; drying defects, none; drying shrinkage, 0.0 percent; dry strength, low.

Slow-firing Test

<i>Temperature °F</i>	<i>Color</i>	<i>Mohs' hardness¹</i>	<i>Total shrinkage, percent</i>	<i>Absorption, percent</i>	<i>Apparent porosity, percent</i>	<i>Bulk density, g/cu cm</i>
1,800	Tan	Poor bond	—	—	—	—
1,900	Tan	2	2.5	30.2	41.9	1.39
2,000	Tan	3	5.0	27.1	39.3	1.45
2,100	Reddish brown	4	7.5	17.1	28.5	1.67
2,200	Dark brown	5	10.0	11.6	20.9	1.81
2,300	Dark brown	6	10.0	1.7	3.0	1.77

¹ In clay evaluation terminology, the term "poor bond" is used to designate materials whose hardness is less than 2 on the Mohs' scale of hardness.

Bloating Test: Negative.

Other Tests: None.

Remarks: Low green strength. Fair color at 2,200° F.

Potential Use: Might possibly be used as a nonplastic in face brick mixtures.

Note: The data presented here are based on laboratory tests that are preliminary in nature and will not suffice for plant or process design.

BOG SIX (BAYLORS MUD POND)

Sample Number: One.

Location: 41° 37' 3" N.; 75° 43' 44" W. Dalton, Pa., quadrangle (7½-minute).

Description of Material: Soft, light-gray clay, occasional traces of red, slightly silty.

Raw Properties: Water of plasticity, 58.0 percent; working properties, low plasticity; drying defects, none; drying shrinkage, 2.5 percent; dry strength, low.

Slow-firing Test

<i>Temperature °F</i>	<i>Color</i>	<i>Mohs' hardness¹</i>	<i>Total shrinkage, percent</i>	<i>Absorption, percent</i>	<i>Apparent porosity, percent</i>	<i>Bulk density, g/cu cm</i>
1,800	Beige	Poor bond	2.5	—	—	—
1,900	Beige	Poor bond	5.0	52.8	59.1	1.12
2,000	Light brown	Poor bond	7.5	41.2	52.3	1.27
2,100	Dark brown	3	17.5	18.0	18.0	1.72
2,200	Dark brown	4	20.5	9.5	16.7	1.76
2,300	—	—	Expanded	—	—	—

¹ In clay evaluation terminology, the term "poor bond" is used to designate materials whose hardness is less than 2 on the Mohs' scale of hardness.

Bloating Test: Negative.

Other Tests: pH, 5.1. Not effervescent in HCl.

Remarks: Low dry strength. High firing shrinkage. Abrupt vitrification.

Potential Use: Not suitable for use in vitreous clay products.

Note: The data presented here are based on laboratory tests that are preliminary in nature and will not suffice for plant or process design.

